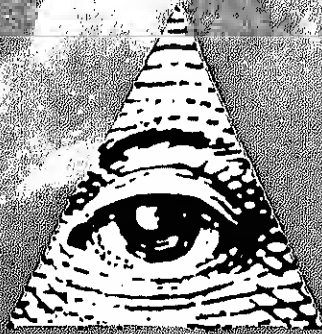
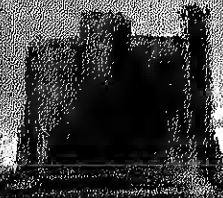
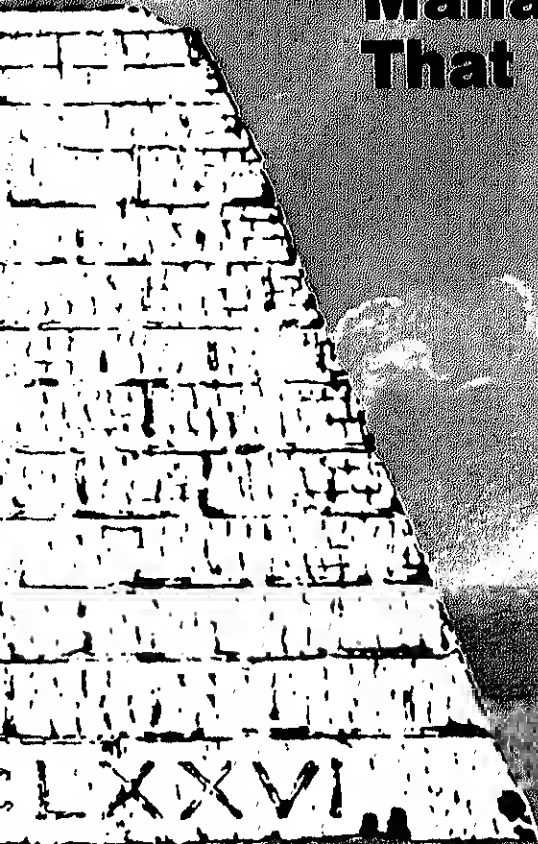


Journal

Second Quarter 1982



Management Strategies That Work



2 How the Air Force capitalized on a faltering airline industry

Major General Kenneth L. Peek, Jr.

proach were keys to the success of the Air Force Volunteer Reserve Officer Recall Program. Facing a major deficit of rated officer pilots, the Air Force recruiting team quickly took advantage of the effects of a declining economy on the civilian airline industry. In this article, the author describes how the Air Force successfully shaped its recall campaign and administrative procedures to help reduce the pilot deficit.

8 Concepts of federal procurement: the award fee approach

Raymond G. Hunt

Proportionately, cost-plus-award-fee contracts account for relatively few military procurement actions. Yet award fee procedures can be singularly effective in promoting sound program management, particularly in an environment—such as research and development—that involves substantial uncertainty about a contractor's ability to perform. This article explains the award fee approach, discusses its origins and development, takes up objections to it, and points out its policy implications.

18 The economics of sex integration: an update of Blinkin and Bach

*Anne Holberg
and
Patricia J. Thomas*

Greater numbers of women in uniform have had an impact on the military in several key areas. One of these is cost, and this article examines some of the financial implications of sex integration in the armed services. Specifically, the authors consider costs in four areas for the 1975 complement of Navy enlistees: dependents, absenteeism, recruiting, and attrition. While results in individual categories varied, women in the 1975 group generally proved more cost-effective than men.

26 CH-47 modernization program: on schedule and within budget

Geoff Sutton

Though delays and cost overruns on major acquisition projects have become fairly commonplace, some programs can stay on schedule and within budget. Boeing Vertol's modernization of the CH-47 Chinook helicopter, accomplished under an award fee contract let by the Army, is a case in point. Cooperation between customer and contractor was one key to the success of this remanufacturing effort; a realistic and comprehensive program management strategy was another. This article highlights aspects of both.

The *Defense Management Journal* is a quarterly publication of the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). As a forum for the interchange of ideas, the *DMJ* publishes articles on current defense policies and on methods for improving defense management. Unless otherwise stated, the views herein are those of the authors and are not

necessarily those of the Department of Defense or any of its elements.

Address all correspondence to: Editor, *Defense Management Journal*, OASD (MRA&L), Cameron Station, Alexandria, VA 22314. You can call *DMJ* at (703) 325-0340 or AUTOVON 221-0340.

Lieutenant Colonel William F. Moore, USAF

Typically, the government uses a prime contractor management structure to acquire major weapon systems. One large contractor, responsible for subcontracting component systems, integrates those components into a functional whole. This article discusses the associate contractor strategy, a less commonly used alternative, under which the government awards several relatively small contracts for subsystems and retains responsibility for integrating deliverables into the end system.

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Controlling federal spending

Randy L. Briggs

Historically, defense expenditures have been the most controllable portion of the federal budget. The budgets of many civilian programs, on the other hand, are relatively uncontrollable because their spending levels are set by law and cannot be reduced, nor the programs eliminated, without a change in legislation. As the author explains in this article, use of multiyear contracting for defense procurements could also reduce the controllability of the defense budget and thus of the federal budget overall.

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Measure for measure: DoD plans for metrics

Gary R. Dillard

With passage of the Metric Conversion Act in 1975, Congress committed the United States to voluntary conversion to the metric system of measurement. Since then, the Defense Department has been coordinating its conversion efforts with American industry and has made steady progress in metricizing DoD systems, procedures, and operations. This article reviews DoD initiatives and discusses how defense planners are accommodating national security requirements to a voluntary changeover to the metric system.

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News summary and calendar

Studies prepared by DoD and the Congressional Research Service point to serious problems in meeting the national demand for technical skills; a newly established oversight office will monitor developments in various DoD management areas.

Secretary of Defense: Caspar W. Weinberger
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On a tailoring airline industry

By MAJOR GENERAL KENNETH L. PEEK, JR.

By tailoring an existing recruiting program to meet changing economic circumstances, recruiters persuaded former military pilots to leave the civilian marketplace and rejoin the Air Force.

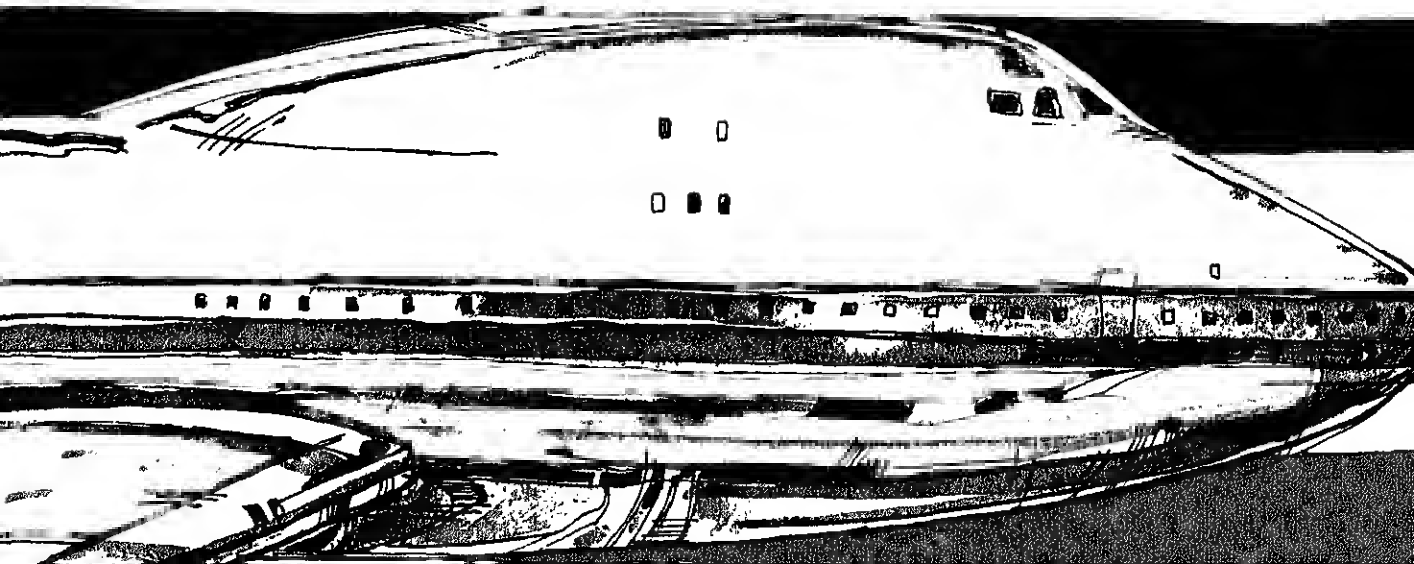
Deregulation of the airline industry in the fall of 1978 was expected to result in unprecedented industry expansion and record profits. In fact, industry profits for 1978 far exceeded \$1 billion. In the year immediately following deregulation, 60 new commuter airlines started operations, scheduled carriers added flights in more than 100 cities, and 35 carriers began serving 231 routes not previously flown by the lines authorized to use them.

The outlook for the industry was so bright that the Las Vegas-based Future Airline Pilots of America projected that the demand for commercial airline pilots during the period from 1979 to

1983 would reach 11,000. Approximately half of the new hires would be needed because of industry expansion and half to replace World War II-trained pilots nearing mandatory retirement. Nearly 1,000 commercial airline pilots retired in 1981 alone, for example.

The unprecedented hiring pace of the airlines during the late 1970s seemed to warrant such optimism. In 1977, the industry had hired 1,446 new pilots and recalled 1,185 pilots on furlough. During 1978, an additional 4,113 new pilots joined the ranks, followed by 3,000 more in 1979. Rapid growth soon came to an end, however, to be re-

ILLUSTRATION BY RALPH BUTLER



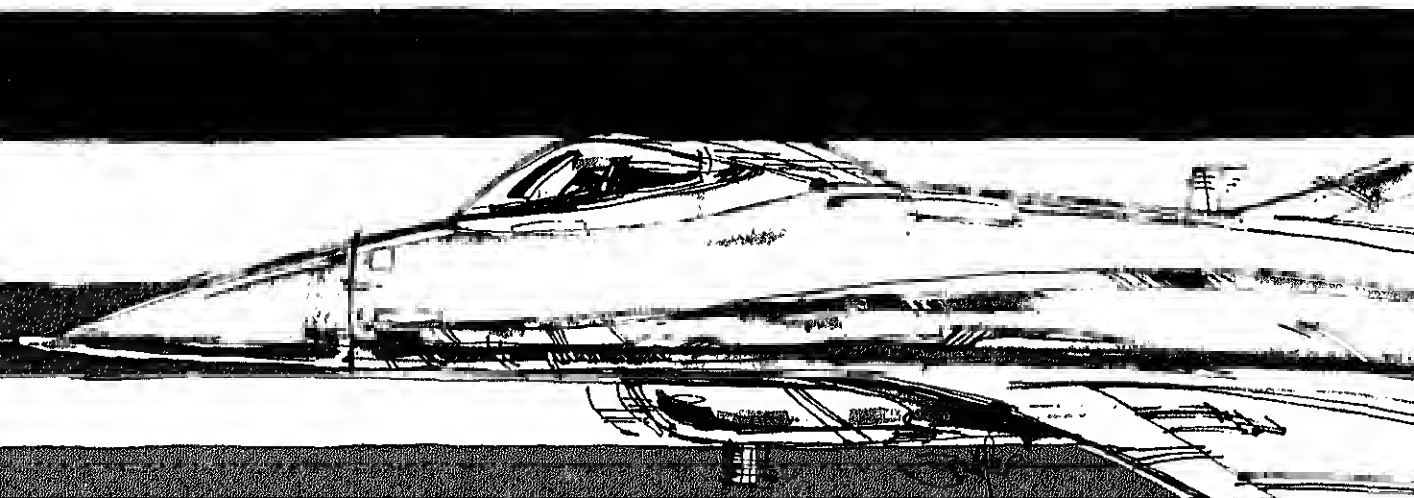
Retrenchment within the industry coincided with an increasingly serious shortfall among Air Force pilots. Historically, approximately 50 percent of new airline hires had been military trained, and during the 1970s, that figure grew to 75 percent. In 1977, the Future Airline Pilots of America took a sample of more than 400 new hires and found that 77.8 percent had received military training. With the airlines expected to continue hiring an average of 2,000 pilots annually, some 12,000 Air Force pilots left the service in the late 1970s, in anticipation of getting in on the ground floor of an historic industry expansion.

Admittedly, airline hiring was not the only cause of Air Force retention problems. Two successive years of service pay caps was a contributing factor, as was the momentum of the post-Vietnam force drawdown. In addition, although the need for increased emphasis on retention was evident, the substitution of retention apparatus for the early-out machinery was not yet complete. The high salaries attainable after a few years with the airlines were also attractive to military pilots. In short, a combination of civilian and service-related circumstances caused the continuation rate for 6-to-11 year Air Force pilots to plummet to an all-time low.

pilots, with increased shortages projected in future years. Almost overnight, a surplus of pilots had become a shortage.

Although the exodus of rated officers posed an immediate problem, the numerical shortage was one the service could rectify over time as airline hiring stabilized. More significant was the loss of experience within certain year groups. Since the military lacks the lateral entry provisions of corporate organizations, the experience shortfall, if not addressed, would remain with the Air Force for the next 10 to 15 years. The cost of training entry-level replacements is significant, but the expenditure in time and money to age new pilots as replacements for experienced ones is prohibitive. A change in the world economy, however, made possible an alternative to the latter.

Air Force retention trends traditionally lag nationwide economic trends by as much as a year; and in the fall of 1979, the airline industry's euphoria was shaken when the Organization of Petroleum Exporting Countries imposed a series of oil price hikes. Significant increases in the world price of oil, including the cost of aviation fuel, added approximately \$2.4 billion to the airlines' costs—an amount double that of the industry's record profit of 1978. These financial setbacks turned the airlines' growth spiral into a spin, and



By the end of 1980, 3,400 airline pilots were on furlough.

The Air Force had begun a program to allow former officers to return to active duty in January 1978, but the program provided few accessions during its first year. Attempts to broaden it in FY 1979 and FY 1980 included a direct mail campaign to over 8,000 Reserve officers, which helped to increase accessions significantly; but only 40 percent of the 812 officers who returned during these two years were pilots. Faced with a significant shortfall in middle-grade rated experience, the Air Force established a quota of 325 pilots within the overall FY 1981 goal of 550 officers.

Compressing a two-year recall quota into a single year was an ambitious goal, but the economic situation of the airline industry offered a tempting target. Given the percentage of military pilots the airlines had hired over the previous few years and their use of seniority lists as a basis for furloughs, estimates indicated that at least 1,500 of the furloughed airline pilots had separated from the Air Force within the last four years. Because many of them continued their military flying affiliation through the Air National Guard or Air Force Reserve, training costs to return these officers to active duty would be relatively small. In fact, 46 percent of those pilots who returned to active duty before October 1980 were assigned directly to operational units. The remainder attended only those courses required to achieve the level of proficiency required for their assignment. The savings in training costs possible in returning an experienced officer to active duty ranged from \$1 million to \$1.5 million per person.

Several factors were likely to make a return to the Air Force attractive to furloughed pilots; among them were an 11.7 percent across-the-board pay increase and a 25 percent increase in flight pay, which became effective October 1, 1980. For junior airline pilots, this pay incentive often represented only a slight decrease and, in some instances, an actual increase over what they had been receiving from the airlines. Personnel management

agement. Many, for example, were impressed by the Air Force Manpower and Personnel Center team visits to residential areas. One jobless pilot commented that because he didn't have to "crawl out his hands and knees to Randolph AFB," the recall program clearly became a viable option.

To take advantage of this situation, the Air Force launched an aggressive public affairs campaign in October 1980. The airlines, airline unions, and associations provided data on the number of furloughed pilots, by airline, which Air Force personnel matched against those locations in which airlines domiciled their crewmembers. This enabled the Manpower and Personnel Center to identify those cities used as major domiciles by airlines furloughing large numbers of crewmembers. Program planners then targeted those cities—Denver, Dallas-Fort Worth, Los Angeles, Chicago, and New York—for the campaign.

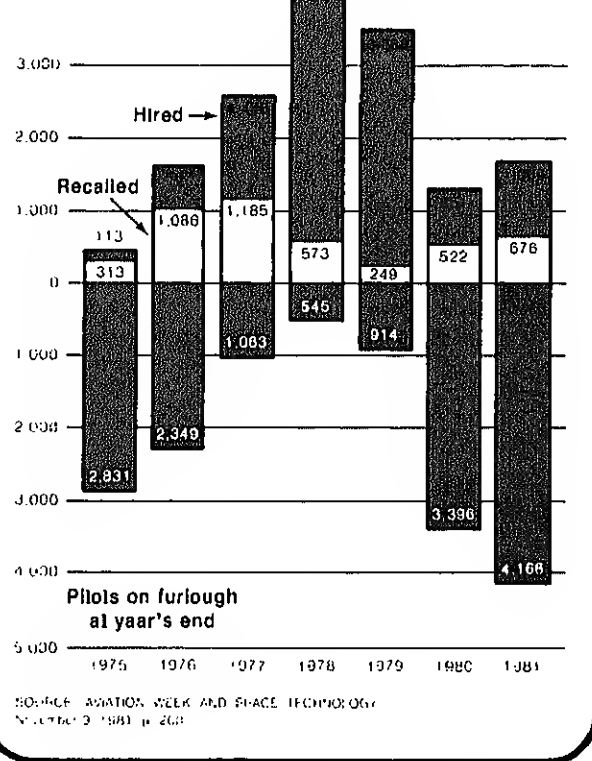
The pilot recall plan called for a major publicity and advertising campaign that emphasized a visible Air Force presence in the targeted cities. A team of three officers visited each city to personalize communications with potential recallees and also to give the campaign standing as a news event with local appeal. The team included a pilot and a weapons systems officer, who conducted briefing sessions and individual consultations with interested airline pilots; the third member was a public affairs officer whose task was to facilitate media activities.

Careful planning was an important component of the campaign, but it also benefitted from several external factors. National defense and the state of the nation's military forces, for example, were prominent issues during the presidential campaign. Moreover, the economic health of the airlines and the continuing pilot furloughs had already become significant media issues, particularly in several target cities. Dallas, for instance, is the headquarters for Braniff International and American Airlines, both of which were furloughing pilots heavily at the time. A visit by the recall team to a city where major job cuts were taking place

several weeks before each visit the local Air Force recruiting squadron issued a news release, purchased advertising space, and obtained public service time to announce the visit. In addition, either the Air Force Office of Public Affairs or the recruiting squadron's advertising and publicity officer at each location made initial contact with local aviation, military, and business editors and reporters to determine interest in the story. The news media also received a background paper, which provided data on the program and highlighted national defense and airline industry issues.

Since neither news releases nor advertising guaranteed that furloughed, or soon-to-be-furloughed, airline pilots would hear of the program, Air Force sponsors used several other methods to publicize the team visits. Letters went to the Airline Pilots' Association's master executive council representative for each airline, advising them of the dates and location for each visit and requesting their support in publicizing it among their members. In most instances, they either announced the availability of the Air Force team in membership meetings or posted a notice on bulletin boards. The official publication of the Airline Pilots' Association, *The Airline Pilot*, also published two articles on the Air Force recall program. The Future Airline Pilots' Association monthly newsletter, which closely tracked hiring and furlough trends, likewise published notices on the opportunity to return to active duty. The president of the Allied Pilots Association, representing all American Airlines pilots, wrote to each furloughed pilot about the program itself and the time and location of the team visits. He also made the Association's conference room in Dallas available for team briefings.

Although the airline industry provided no direct support, it did indirectly assist the program. A number of pilots hesitated making a four-year commitment because they feared loss of airline seniority if recalled while under obligation to the




that if scheduled for recall while fulfilling their service obligation, they would be placed in military leave-of-absence status and thus would not lose seniority.

Air National Guard and Air Force Reserve officers, although themselves part of the target audience, were extremely valuable in publicizing the program. Many Guard and Reserve officers knew former Air Force officers on furlough from the airlines and often shared information on the recall program with these pilots. To reinforce this word-of-mouth communication, the Air Force sent postcards to Reserve officers in advance of team visits to target cities. The message apprised them of the time and location of the briefings and consultations and requested that they pass the information on to anyone they thought might be interested. Also, the commanders of the Air National Guard and Air Force Reserve units at Chicago's O'Hare

But the news media also only consider the event newsworthy if a significant number of interested, furloughed airline pilots attended. In many instances, the media also wanted assurance that they could interview furloughed pilots in addition to team members. These preliminary publicity efforts ensured sufficient attendees and willing interview subjects at the initial sessions.

During the earlier days of the program, delays in processing individuals for return to active duty sometimes affected a pilot's decision to rejoin the Air Force. The Air Force Manpower and Personnel Center therefore took several steps to halve the 120-day processing time. Transferring the active duty processing work unit from the Air Reserve Personnel Center to the Manpower and Personnel Center itself, which eliminated some duplicative effort and mailing delays, was one of these. To further reduce processing time, recall selection boards were held monthly rather than every two months, and medical facilities were asked to expedite the processing of physicals. Other steps included reduction of the assignment determination process, implementation of a system to track recall processing, and modification of selection and administrative procedures, which cut 10 days from the processing time. Because furloughed individuals were often under temporary, but severe, financial stress, timely, expeditious processing of applications was essential. Yet the system had to be flexible enough to delay returns, by several months if necessary, when officers had other commitments to fulfill.

In cities not visited by a recall team, potential applicants could call a toll-free number to discuss the program with the recall processing unit at the Air Force Manpower and Personnel Center. Applications were mailed upon request. This toll-free line was highly effective; at times, the number of inquiries received at the center averaged more than 50 calls per day.

The extent and impact of news media coverage was greater than expected. In Denver, for example, all three television  affiliates carried

within 24 hours, all major broadcast and print media in Denver had announced the team's visit to the area, virtually assuring maximum exposure to the target audience. Nearby Colorado Springs provided similar media exposure.

Media coverage in Dallas was comparable, but through aggressive placement actions, the team's visit to that city attracted national attention as well. An Associated Press wire story and an article in *Aviation Week & Space Technology*, which appeared in advance of the visit, brought numerous inquiries from across the country, including more than 50 from Dallas alone before the team arrived there. A unit from *NBC Nightly News* interviewed the team upon arrival, and the network broadcast the session nationally that evening. Later that same day, ABC News also did an interview, which it aired during the *Good Morning America* program. The national attention focused on the recall program in Dallas helped foster continued media interest in Los Angeles, Chicago, and New York.

During the Dallas and Denver visits, the Air Force surveyed all those who made inquiries and attended briefings to insure that communication efforts were concentrated on the most effective media. Respondents provided information concerning their current and past flying history and how they learned about the program. Among those completing the survey in Dallas, nearly 95 percent reported news media coverage of the recall team's visit as their primary source of information. However, the number of individuals responding to paid advertising, according to the survey, was negligible. This was a significant finding, because advertising costs for other cities on the team's itinerary were to be considerably higher; survey results enabled the Air Force to allocate that money more effectively by concentrating it in more visible media.

In arranging news coverage in Los Angeles, Chicago, and New York, Air Force planners continued to modify their strategy as experience dictated. Both the *Los Angeles Times* and *Herald-Examiner*, for example, carried prominent lead

Chicago was comparable to that in Dallas. In New York, the team conducted nearly 50 interviews with newspaper, magazine, radio, and television media in the metropolitan area. Recall team members were featured guests on television and radio talk shows in both cities.

The number of applications for return to active duty far exceeded program goals. In less than three months after the first visit, 493 pilots applied to rejoin the Air Force, a figure that represented more than 150 percent of the fiscal year goal. Similarly, total applications, including those from navigators, engineers and support officers, exceeded the program goal of 550. Because the greatest need was for rated officers, Air Force officials revised the quota to accept more rated officers and fewer support officers.

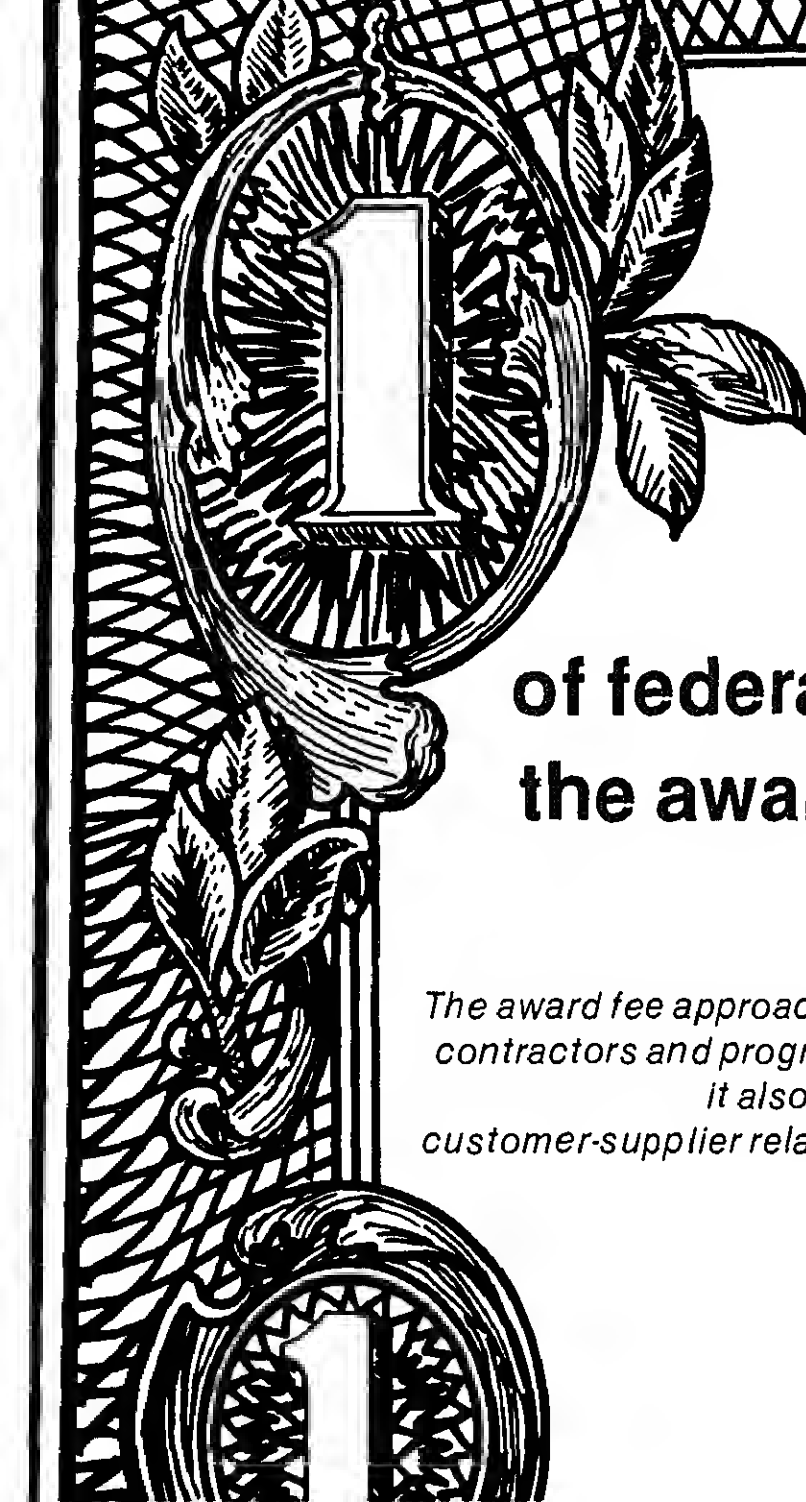
Because the media campaign proved so successful, Air Force planners decided to end it with the New York visit. Continuing the program, given end-strength limitations set by the Congress, would have meant either rejecting large numbers of well-qualified applicants or subjecting them to extensive delays before return to active duty. Either course of action would have gained negative publicity for an otherwise positive recruiting effort that had benefitted many. Moreover, national media coverage and the toll-free telephone line had already given the recall program high visibility and accessibility. Even after the campaign ended, requests for applications via the toll-free Wide Area Telephone Service averaged 75 calls per week. Thus, additional expenditures for further team visits would not have been justified.

While the Voluntary Reserve Officer Recall Program was definitely a success, it was not without problems. In one nationally syndicated newspaper article and one network news broadcast, for example, reporters erroneously stated that returning pilots would have their choice of assignments. In fact, that option was not available, though officers did not have to make a final commitment to return to active duty until their assignment was known.

process, those unfamiliar with rank-ordering preferences would understandably refer to it as "choice of assignment."

Such problems were few, however; and overall, the results of the Reserve officer recall program represent an impressive achievement. Air Force program planners made it possible by tailoring management actions to external factors. The financial condition of the airline industry and the attention given to national defense issues during the presidential campaign combined to create a fertile environment for action. The media campaign was well-timed, well-targeted, and carefully organized. Administrative flexibility on the part of Air Force personnel in minimizing processing time and quickly responding to inquiries was also instrumental in attracting a large number of volunteers. As one newspaper editorial phrased it, the program stands as an example of "quick thinking in seeing a recruitment opportunity and pursuing it to the end that a bad situation can be turned around to the advantage of all." **DMJ**

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Concepts of federal procurement: the award fee approach

By RAYMOND G. HUNT

The award fee approach to federal procurement affects contractors and program managers in important ways; it also involves key assumptions about customer-supplier relations in government acquisition.

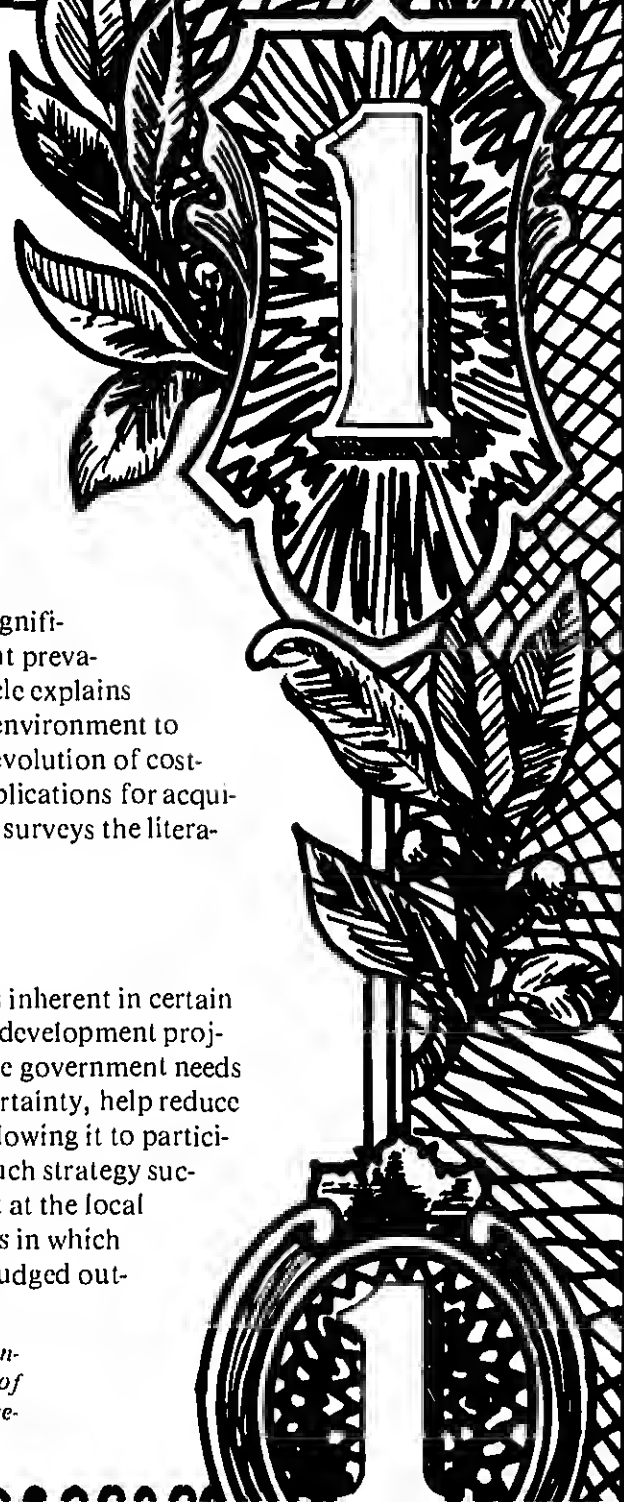
Under award fee provisions in federal contracts, government monitors unilaterally determine all or part of a contractor's fee on the basis of subjective, after-the-fact evaluations of contractor performance. This approach to contracting represents one of the genuine novelties of federal procurement practice and a departure from the well-known and widely used cost-plus-fixed-fee, or no-incentive, contracts. In fact, in FY 1978, cost-plus-award-fee contracts accounted for only about 2.9 percent of the net value of DoD procurement actions and about 0.5 percent of all military prime contracts.

The award fee approach is more than merely a curiosity, however; its use implies at least a latent policy choice that gives award fee contracting a significance quite out of proportion to its modest current prevalence among U.S. procurement actions. This article explains the award fee concept, considers the contracting environment to which it is best suited, and traces the origins and evolution of cost-plus-award-fee contracts.* A discussion of its implications for acquisition policy follows, and, finally, a bibliography surveys the literature available on the subject.

The award fee concept

Uncertainty about a firm's ability to perform is inherent in certain kinds of contracts—those involving research and development projects, for example. When letting such contracts, the government needs an acquisition strategy that can adapt to this uncertainty, help reduce it, and safeguard the government's interests by allowing it to participate in management of the acquisition process. Such strategy succeeds by fostering effective program management at the local level. A recent Air Force study identified ten ways in which award fee contracts, which reward performance judged out-

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• Recognizes limitations in the ability of the contractor's top management to control program operations.

- Stimulates both formal and informal communication.

- Recognizes the variability of human organizational motivation.

- Leaves to contractors the task of motivating their own personnel.

- Views the acquisition process as a dynamic one.

- Is flexible and provides room for human judgment.

- Simplifies contractual provisions.

- Assumes that profits are earned rather than simply negotiated.

After a decade of research on award fee contracting and related subjects, researchers have concluded that the method "works." It works, however, not because of its technical properties as a contract, but because of the managerial environment it fosters in the government program office. Among contractors, award fee provisions encourage "an attitude of responsiveness to government direction," while among federal officials, "they enhance the latitude within which government managers may influence the directions and outcomes of the programs for which they are responsible." Award fee procedures also "help discipline and organize actions within the government program office as well as . . . relations with contractors."² By facilitating the government program manager's task, award fee approaches to acquisition place the kind of emphasis on local program management called for by the Office of Management and Budget, which, in Circulars A-109 and A-76, stresses local program management

in federal contracts at least since the 1950s when, according to a cost-plus-award-fee *Guide* issued by the National Aeronautics and Space Administration in 1967, they were used in certain contracts for aircraft maintenance and overhaul. Extensive use of the award fee technique, however, dates from the early 1960s. In July 1962, for example, a Navy logistics support contract—transferred to Army two years later—for operations at Kwajalein and Eniwetok Islands was written basically as a cost-plus-incentive-fee contract, but with explicit subjective award fees for control of staffing, personnel turnover, and quality of performance. Thanks to growing interest, mainly in NASA and the Navy, this practice of occasionally incorporating subjective, award fee-like features into contracts otherwise dominated by fixed fee or automatic, predetermined incentive fee structures gave way to more comprehensive application of a new contract type: the cost-plus-award-fee contract.³

The Navy's first "pure" cost-plus-award-fee contract, written in March 1964, covered operation and maintenance of instrumentation and range facilities in Los Angeles. Before that, during 1962-63, officials at NASA's Goddard Space Flight Center and Murray Weingarten, then Vice President for Operations at Bendix Field Engineering (Bendix Radio), negotiated the first full-fledged cost-plus-award-fee contract anywhere. This two-year, \$10 million contract covered operations, maintenance, and engineering services for Project Mercury tracking and communications stations. It provided a fixed fee of 3 percent, plus an award fee up to 7 percent, to be based on after-the-fact, quarterly evaluations of Bendix performance. Judgments concerning award fees were unilateral and not subject to dispute. In making

¹ R. G. Hunt, "Use of the Award Fee in Air Force System and Subsystem Acquisition," 1980. Complete documentation for this and other citations and quotations not specifically or fully footnoted will be found in the bibliography at the end of the article.

² R. G. Hunt, "Use of the Award Fee in Air Force System and Subsystem Acquisition," 1980, pp. 193-94.

³ Interestingly, mixed incentive contracts have recently regained popularity. The Air Force, for example, often applies "objective," predetermined incentives to performance costs, but keys award fees to performance quality, schedule, or other factors, including management. The Defense Acquisition Regulations (DAR 3-405.5[h]) expressly authorize mixed incentive structures.

the NERVA rocket program was cost-plus-award-fee. Up to 1966, NASA alone had written 140 cost-plus-award-fee contracts, worth \$1.1 billion, with 90 contractors. Indeed, its increasingly extensive use of award fee methods for a variety of procurements not restricted to support services prompted the agency to commission an evaluation of cost-plus-award-fee contracting by Booz, Allen, and Hamilton. Done during 1965–66, this study concluded that such contracts can deliver tangible benefits regardless of the type of service procured or the dollar value of the contract. It went on to argue the superiority of cost-plus-award-fee over cost-plus-fixed-fee contracts, especially for support services, mainly because of the added profit incentive under the former and the communication it fosters. In addition to encouraging NASA in the use of award fee methods of contracting, the Booz, Allen report stimulated the agency to write a cost-plus-award-fee *Guide* intended to promote greater uniformity of practice.

Whether uniformly applied or not, the use of award fee contracts, in NASA and elsewhere, continued to grow until by 1969 more than 300 such contracts existed government-wide, valued at some \$4.1 billion. As the 1960s ended, only the Air Force, with but four award fee contracts worth about a half-million dollars, was essentially a non-user of cost-plus-award-fee methods. Eventually, however, that service became a much more extensive user. For a 1978–80 evaluation, the Air Force Business Research Management Center, in a not necessarily complete inventory, identified some 27 award fee contracts representing 17 different current or recently completed systems command programs.

Efforts to regulate cost-plus-award-fee at NASA got under way in 1960; formal regulatory coverage began in July 1965. Approval of award fee methods by the Armed Services Procurement Regulations became effective in 1968, following extensive service testing that began, on General

Award fee origins

Apart from these milestones, the origins of the award fee approach to procurement are a bit hazy. For instance, after noting contributions by academicians “engaged in procurement case study research” and by a number of government officials, as well as by “officers of at least two leading prime contractors,” the cost-plus-award-fee *Guide* mentioned above decided against any attempt at attributing “authorship” (p. 5). Subsequently, in 1968–69, Gordon W. Rule of the Navy and James E. Cravens of NASA—who surely deserve to be counted prominently among award fee originators—referred in the *Defense Management Journal* to “several Department of Defense and NASA officials . . . thinking independently about award fee contracts during 1960–61.” Among these officials, in addition to Rule and Cravens, were at least five individuals. One of them was Thomas D. Morris, who, in July 1961, as an assistant secretary of defense, discussed the idea of award fee contracting in cost reimbursement situations at a Joint Industry-Defense Department Symposium of the National Security Industrial Association.⁴ According to Rule and Cravens, Morris’ was “the first public reference to award fees” (p. 27).

While at NASA, before moving to DoD as an assistant secretary of the Air Force, Robert Charles was also a known advocate of using judgmental incentives in preference to no-incentive,

⁴ These are contracts intended for use when the quality of service by a contractor is to be rewarded. Developed by NASA, level-of-effort contracting presumes an ability to specify the services to be provided, but a need to evaluate their quality against mainly subjective standards. Custodial services and computing support, for example, might be contracted for under a level-of-effort arrangement.

⁵ Industry reaction to this new incentive plan was one of complete opposition, according to an article in *Aviation Week and Space Technology*, June 25, 1962, largely because of the plan’s subjectivity and unilateral nature.

also mention Barry Shinto and Robert A. Brooks, assistant secretaries of the Navy and Army, respectively, as early contributors to developing strategies for applying subjective cost effectiveness incentives (p. 28).

The award fee *Guide* also refers to, but does not name, "officers of . . . two leading prime contractors" as progenitors of the award fee approach. Bendix's Murray Weingarten may well have been one of them. The academicians mentioned in the *Guide* surely include Frederic M. Scherer, who devotes a full chapter in his 1964 landmark work, *The Weapons Acquisition Process: Economic Incentives*, to "After-the-fact Evaluation: A New Incentive Approach." He makes no claim there to having invented the approach, but notes instead that several people had been thinking along similar lines in 1960 (including Gerald Siegel, his colleague in the Harvard Weapons Acquisition Research Project). Scherer's published chapter follows the essentials of memoranda he had previously prepared for the secretary of defense, one early in 1961 and another later that same year. In his book, however, he expressly differentiates his own proposal for after-the-fact incentives from DoD award fee developments during 1962 and 1963.

After-the-fact evaluation

The purpose of Scherer's level-of-effort incentive system was to "recognize the fundamental limitation in existing incentive policies and to place a high priority on developing a system of incentives better suited to the environment of technological change and uncertainty in weapons acquisition" (p. 362). His proposed incentive strategy, like award fee practice common today, relied on retrospective evaluations of contractor performance by "knowledgeable persons of sound judgment" (p. 329). Scherer envisaged a central organization of six to ten such persons, called a Performance Evaluation Board, which would make periodic, after-the-fact contractor evaluations and control bias in those evaluations. He

ment sales sets Scherer's incentive strategy apart from customary award fee methodology, which has been exclusively fee-oriented. It was, however, an idea basic to DoD's contractor performance evaluation system,⁶ developed in the 1960s to relate after-the-fact performance evaluation to the source selection process, a goal still largely unrealized. Scherer's method of measuring contractor performance also distinguishes his award fee technique from that of NASA and DoD. Those two agencies have consistently used either weighted or unweighted aggregations of ratings of contractor performance on several separate performance factors (for example, controlling personnel turnover). Scherer advocated quite a different procedure employing relative *rankings* of contractors derived from paired comparisons of each contractor with all others. Although impracticable when more than a few contracts are to be evaluated at a time, Scherer's method has a number of virtues, which he reviews in his book; but, in any case, the proposal seems never to have been tested. By and large, award fee evaluation procedures have tended to rely on factor-by-factor comparison of a contractor's performance against some nominally constant standard such as the hypothetical "average" or "superior" contractor.

In his book, Scherer also described several advantages of after-the-fact performance evaluation, which are essentially the same as those for which award fee contracting is currently touted: flexibility, enhanced communication between government and contractor, and so forth. He also mentioned some objections to the after-the-fact strategy.

⁶ See Department of Defense, *Guide to Contractor Performance Evaluation* (Washington, DC: Government Printing Office, 1966); W. H. Gregory, "DOD/NASA Study Common System for Rating Company Performance," *Aviation Week and Space Technology*, February 4, 1963, p. 95; H. Taylor, "System Will Rate Contractors," *Missiles and Rockets*, February 11, 1963, p. 14; "Contractor Evaluation Comments Asked," *Aviation Week and Space Technology*, April 15, 1963, p. 32.

contract objectives and evaluation criteria, and subjectivity and bias in performance evaluation. Scherer's comments on these objections are worth summarizing because one continues to hear the same objections made to award fee strategies.

After-the-fact performance evaluation methods may smack of socialism because they necessarily imply foresight and planning, and thus, in a manner of speaking, government "manipulation" (the word is Scherer's) of private firms. Scherer admitted that, in a sense, this is true, although overstated; and anyway, what are the alternatives? Not planning certainly is not one of them. Moreover, in Scherer's view, alternative incentive systems cannot be counted on to motivate optimal and efficient program management.⁷ The blunt reality is that one cannot have true private enterprise in a nonmarket environment (such as defense contracting). Consequently, the government has often turned to direct controls, which, Scherer argued, is surely a bigger step to socialization of the acquisition process than is planned, after-the-fact performance evaluation.

Scherer thought that unilateral government evaluation and reward of contractor performance, while not without drawbacks, were necessary in order to avoid protracted stalemates that would defeat the prime objective (as Scherer saw it) of penalizing poor performance.⁸ Besides, he argued, circumstances are no different in the mar-

termining fee outcomes, a custom which he believed had the effect of defeating most contractual incentive schemes and so needed changing.

Concerning allocation of responsibility, certainly contractors often are not solely responsible for program outcomes. But even when responsibility is shared, Scherer suggested, the contractor remains an accountable party. And again he pointed out that the "impersonal market forces which confront firms outside the weapons industry are no more equitable in this respect" (p. 353).

Scherer also discounted the logic of objections to after-the-fact evaluations that picture them as stimulants to bureaucratization of the acquisition process and delay of reward. In fact, however, both phenomena are sometimes observable in award fee organizations. To a significant degree, informal processes stimulated by award fee arrangements ameliorate or compensate for them and they are manageable, but they cannot be dismissed.

Unclear contractual objectives and evaluation standards, in Scherer's opinion, are in some measure inevitable, especially in early stages of the acquisition process. But uncertainty is not removed by formulating detailed performance targets that merely paper over genuine disagreements or basic unknowns. In order to reduce uncertainty, one first must do something and then evaluate the results of that action. Scherer advised taking the contractor's difficult position into account in these evaluations; and he also stressed the need to give contractors some discretion in how their work is done, which adds a bit of risk but is not without compensation.

Subjectivity and bias in performance evaluation—indeed, the whole subject of performance evaluation methodology—is both a crucial and a neglected area. Scherer maintained that subjectivity was inescapable in performance evaluation because we simply do not have fully objective measures of efficiency, creativity, ingenuity, and the like. Moreover, objective standards often

⁷ Scherer reviews some reasons for this in his book. See also R. G. Hunt, "The Use of Incentives in R&D Contracting: A Critical Evaluation of Theory and Method," Technical Report, NASA Grant NGR33-015-061, State University of New York at Buffalo, December 1971.

⁸ Penalizing poor performance is an inevitable part of a fee-determining evaluation scheme, but, in the case of the award fee, I would argue, only as a by-product of its primary objective of rewarding good performance. It is a matter of perspective and emphasis (see R. G. Hunt, "Use of the Award Fee in Air Force System and Subsystem Acquisition," pp. 71-72). Also, it may be noted that some award fee plans have included provision for contractor participation in or appeal of fee determination. Unfortunately, we know little about the

reasonably consistent correlation between reward or penalties and performance. He discussed some difficulties in doing this, given the complex, multidimensional aspects of program performance, but emphasized that we do not need perfect measurement. He concluded, albeit from some slender empirical evidence, that the kinds of judgments needed for after-the-fact evaluations could be reliably made. Wild errors, he thought, were unlikely. Scherer's basic position on this point is a reasonable one, but unhappily the kind of technical work needed to inspire full confidence in subjective performance evaluation strategies has yet to be done.

The rationale for award fee contracting

Whereas NASA and DoD used award fee contracting in the early-to-mid-1960s mainly for support services, Scherer perceived the greatest utility of after-the-fact incentives in research and development applications. He apparently saw this kind of methodology as a general solution to problems of uncertainty and the attendant need for change and flexibility in such applications and in similarly dynamic acquisition processes—problems that bedeviled both fixed-price and predetermined-incentive contracting.

Interest in award fee contracting emerged and grew in the 1960s' context of enthusiasm for devising automatic, objectively determined incentive formulae for determining contractor profit in cost-plus situations. The impetus behind award fee concepts was thus the same as that for incentive contracting: a desire to contract in ways that would capitalize on the motivations of the contractor and associate a contractor's profit with variations in his actual performance. The after-the-fact award fee contracting alternative resulted from painful recognition of problems of uncertainty associated with setting contract performance targets very far in advance of actual performance, from a need for programmatic flexibility in the face of changing situations, and from acknowl-

edgedly, and not incidentally, the fact that the award fee represented a situationally constrained special case of incentive contracting, principally an alternative to cost-plus-fixed-fee contracts. And of course the acquisition literature and regulations usually describe it today as a contract-type intermediate between cost-plus-fixed-fee, on the one side, and cost-plus-incentive-fee on the other. There is, however, another view.

Award fee as a management model

Its originators and, for the most part, its proponents since, have seen cost-plus-award-fee merely as an incentive variant representing no radical departure in federal acquisition theory. Not everyone has been quite so blithe, perhaps (see Scherer, p. 351, for instance), but few have argued that award fee contracting constitutes any kind of serious reconceptualization of the basic government-contractor, public-private sector exchange relationship. That it nevertheless suggests such a reconceptualization seems apparent upon reflection.

Government-contractor exchange relationships organized along award fee lines imply choice of what I have elsewhere called a shared leadership and, more recently, a joint management or J-model of program management and system acquisition.⁹ The essence of J-model acquisition is administrative exchange among organizational elements of the contracting parties, shared decision-making, and a more or less even distribution of power among the principal parties to the contract.

To clarify the J-model concept, we can contrast it with customary notions about the nature of customer-supplier relations in government systems acquisition. Let's call this more familiar concept a formal F-model. It views the working relationship

⁹ See R. G. Hunt and I. S. Rubin, "Approaches to Managerial Control in Interpenetrating Systems: The Case of Government-industry Relations," *Academy of Management Journal*, June 1973, pp. 296-311; R. G. Hunt, "Use of the Award Fee in Air Force System and Subsystem Acquisition," pp. 17-24.

unambiguously specified in a formal contract, but that otherwise private, intra-organizational management decisions independently determine and control the actions of the parties. In the F-model, the government's program responsibilities are regulatory rather than managerial. It regulates certain program inputs and vetoes outputs but does not control throughput decisions, which are the contractor's exclusive domain.

A J-model, on the other hand, looks upon the government-contractor relationship quite differently, at least in systems acquisition and kindred environments. It envisages a dynamic acquisition environment and recognizes a limited division of labor between the two parties, but it assumes informal cooperation at operation interfaces, continuous explicit and implicit negotiation of the work to be done and of responsibility for doing it, shared decision-making, and friendly, informal (or no more than administrative) resolution of disputes. Only when informal negotiations break down or if the costs of compromise are excessive to either organization do the parties resort to legal or other formalistic procedures.

Each of these models is obviously idealized. Conditions in the real world are not likely to correspond completely to the assumptions of either one. But on the whole, the real world of research and development or major systems acquisition unquestionably corresponds more closely to the premises of a J-model than to those in F-forms. As I have argued elsewhere, in these contexts, if not everywhere, the customer-contractor relationship is essentially a single performance unit shaped not only by the separate properties of contractors and customers, but also by the nature of their working relationship and by the technological, social, economic and political framework within which

... is a thorough realization of the intimacy of relations among program planning, contracting, and program management. Today's era of the new Federalism calls for a shift of focus from the mere mechanics of contracting to the dynamics of planning, negotiation and administration. The award fee approach is conceptually consistent with such a broadened perspective and promises a means of translating it into [practice]."¹⁰

Most of the real problems in award fee practice come to rest at the program level. They translate there to management strategies and tactics. A capability for sophisticated program management is surely decisive for effective systems acquisition. Such a capability, however, implies the fundamental precondition of managerial rather than contractual acquisition strategies, an orientation to which the government is not yet clearly committed. Whether or not to accept a joint government-contractor management model of system acquisition as valid in the United States and to follow its methodological implications—via award fee techniques and otherwise—remains a major acquisition policy choice. **DMJ**

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¹⁰ See R. G. Hunt, "Extracontractual Influences in Government Contracting," Final Report, NASA Grant NGR33-015-061, State University of New York at Buffalo, March 1971, pp. 29-30.

¹¹ R. G. Hunt, "R&D Management and Award Fee Contracting," p. 30.

The following is a bibliography of writings about award fee contracting which are known. Whether or not this listing is exhaustive, it does present the results of an extensive search conducted recently under contract with the Air Force Business Research Management Center at Wright-Patterson AFB, Ohio.¹² The search included custom bibliographies produced by the Defense Logistics Studies Information Exchange, the catalog numbers (LC codes) for which, when known, are given in parentheses following each entry. One thing clear from the bibliography is that little has been published on award fee contracting. The literature consists mainly of unpublished transcripts of occasional speeches or papers at various meetings and intragovernmental technical papers, policy statements, or procedural memoranda. A few such items are included in the bibliography because they seemed especially noteworthy. Except for technical reports, however, this listing does not capture most such unpublished material. I am especially grateful to David E. Hoxie of the State University of New York at Buffalo School of Library Science for his excellent bibliographic assistance.

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In 1977, the Brookings Institution published *Women in the Military*, a study by Martin Binkin and Shirley J. Bach, as part of its Studies in Defense Policy series. This book, now in its seventh printing, offered readers a provocative analysis of the impact upon the military of increasing numbers of women in the armed forces. It documented many topical issues related to the role of women in the military, including policy implications, women's rights and military benefits, institutional attitudes, and military effectiveness. Of particular interest was the chapter on the economics of sex integration; this article updates that chapter.

Binkin and Bach projected expenses to the military for the following specific areas: one-time adjustments, such as modifications to barracks, ships, and vehicles for women and redesign of clothing and equipment; dependents, which comprised housing, medical care, and travel costs; absenteeism; recruitment; and attrition. On the basis of their predictions, the authors hypothesized that while one-time adjustment costs to accommodate women would be high, these expenditures

would be less than men's losses incurred for alcoholism, drug-related conditions, and disciplinary actions. Recruiting costs were likely to be higher for men than for women, according to Binkin and Bach, because of the greater availability of female high school graduates than of male graduates with comparable backgrounds. The services must spend more to advertise for and recruit men with high school diplomas than they do for their female counterparts.

Overall, Binkin and Bach concluded that women would be somewhat more cost effective than men because of the relatively high quality of the typical female applicant and her lower average number of dependents. Although the authors were able to quantify many expenses associated with both sexes, data were not available to conduct specific comparisons between men and women within each service. This paper presents the results of research undertaken to make such comparisons possible. The purpose of the research was to determine whether data obtained from an actual population

an update of Binkin and Bach

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Financially, women in the military offer an affordable source of high-caliber talent, according to research summarized in this article.

considered monetary costs to the Navy in four areas: dependents, absenteeism, recruitment, and attrition.

All men and women who enlisted in the Navy during calendar year 1975 participated in this study. The four-year enlistment period that began in 1975 allowed a sufficiently long follow-up time to obtain data needed for the comparative analyses. Women who entered active service in 1975 numbered 5,984; the number of men was 88,744.

Data for the study were obtained from the service and medical history files maintained at the Naval Health Research Center, San Diego. The chronological records of all Navy enlisted men and women who began active service in 1975 were extracted from these two data bases. Variables from the service history files included years of schooling, mental group category (based on scores from the Armed Forces Qualification Test), unauthorized absences, desertions, dependents, and separation data. Totals for unauthorized absences and dependents were those as of the date of premature separation or completion of the enlistment. Information from the medical history files included

diagnosis, number of days hospitalized, and year of admission. Frequency distributions by sex were computed for the following variables: number of dependents, unauthorized absences, desertions, primary diagnosis for each hospitalization, and number of days hospitalized.

Costs to the Navy relative to these variables were obtained from several sources. Dependent-related costs were derived from calculations in Binkin and Bach, while costs associated with unauthorized absences and desertions were based on U.S. General Accounting Office figures.¹ Estimated costs for inpatient medical care, another form of absenteeism, amounted to approximately \$157 per day, based on statistics compiled by the U.S. Department of Commerce.² Because of differences in pay scales for the population studied, the cost of person-days lost from duty for both unauthorized absences and hospitalizations could not be computed.

¹ General Accounting Office, *AWOL in the Military: A Serious and Costly Problem* (Washington, D.C.: Government Printing Office, 1979).

² Bureau of the Census, *Statistical Abstract of the United*

supply of high-quality candidates (male high school graduates with aptitude scores in the higher mental group categories of I through IIIb) available for recruitment. Male high school graduates in mental group categories I to IIIa and in category IIIb had considerably higher recruiting costs (\$2,000 and \$1,700, respectively) than those (\$875) for lower-quality men. On the other hand, recruiting costs for women, who typically were high quality or high school graduates in the higher mental group categories, were comparable to those for lower-quality men (\$875). Again, the principle of supply and demand dictates these lower recruiting expenses, because of lower advertising costs and less time and effort expended by recruiters. To determine the recruiting costs for this study, frequency distributions were computed for all male high school graduates in mental group categories I through IIIa and mental group category IIIb; costs for all other men and women were comparable at \$875 each.

Huck and Midlam also developed costs attributed to premature separations into an unrecovered investment curve, which estimated costs related to attrition at various intervals during a first enlistment. Similarly, the current study used reason for separation and duration of active service to tabulate bivariate distributions by specific intervals for both men and women in the 1975 population.

Costs of dependents

Dependent costs tabulated in this study were those associated with housing, medical care, and travel. Consistent with Binkin and Bach, these dependent-related costs exclude other expenses to the military, such as dependents' education, commissaries, and the like. To simplify computation of housing and medical costs, all Navy personnel with dependents were considered in like manner, that is, dependents were claimed for two of the

considerably, depending upon provision of individual or family quarters or payment of cash allowances. Binkin and Bach estimated the overall monthly expenditure at \$52 (\$624 per year) more for personnel with dependents than for those without. Among enlistees of the 1975 Navy cohort, 28,277 men and 1,377 women had one or more dependents. For the two-year period used in calculating dependent costs, housing-related totals were \$35,289,696 for men and \$1,688,576 for women (prorated costs of \$397.66 and \$278.84, respectively). Because of the greater proportion of men with dependents than women, prorated costs to the Navy per man were higher than per woman.

Medical. Costs to the military for each dependent's inpatient and outpatient care, according to Binkin and Bach's estimate, were approximately \$300 per year. Dependents of Navy men in the 1975 cohort numbered 42,457, while Navy women claimed a total of 1,695 dependents. Thus, over a two-year period, medical costs amounted to approximately \$25,474,200 for dependents of Navy men and \$1,017,000 for those of Navy women (prorated costs were \$287.05 for men and \$169.95 for women).

Travel. As expected, relocating a family cost considerably more than relocating a single person. Additional expenses associated with reassigning an enlistee and his or her family were about \$1,144. Moving expenses for two assignments for the 28,277 men and 1,377 women with dependents in the 1975 Navy population totaled \$64,697,776 and \$3,059,056, respectively (prorated costs were \$729.04 for men and \$511.21 for women).

Overall dependent-related costs—the sum of prorated expenses for housing, medical care, and travel—averaged \$1,414 for each male enlistee and \$960 for each female enlistee.

Unauthorized absence

In a recent study of absenteeism, the U.S. General Accounting Office estimated that the military

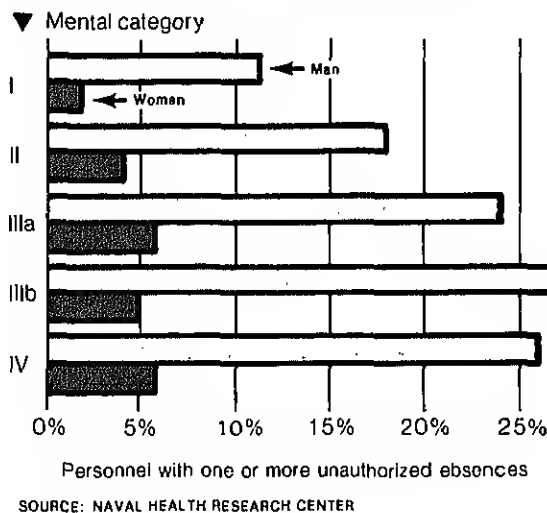
¹ Development of Methods for Analysis of the Cost of Enlisted Attrition (McLean, VA: General Research Corporation, 1977).

reporting, apprehending, processing, trying, and confining the offender. Each unauthorized absence of less than 30 days cost the military an average of \$180. Deserters, or those who were absent 30 or more days, were considerably more costly, at \$904 per incident. On the basis of these figures, the average cost per unauthorized absence was \$189 for men and \$27 for women in the 1975 cohort (see Figure 1). Among men, incidents of unauthorized absence and of desertion numbered 38,281 and 10,932, respectively; the corresponding figures for women were 429 and 93.

The incidence of disciplinary offenses in the military was higher among men of low aptitude than among those who scored higher on the entrance battery.⁵ For women, the frequency distributions differed considerably, primarily because very few women who did not have high school diplomas (or the equivalent) or who did not score in the upper three mental categories were permitted to enlist in the Navy. Thus, the lower unauthorized absence rate consistently reported for women probably reflected their high quality and, as such, may be a gender difference that would narrow if men and women had comparable selection criteria. However, investigation of male and female absenteeism in the 1975 cohort showed that even women scoring in the lowest mental category had a rate of unauthorized absence lower than that of the brightest men (see Figure 1). That is, 6.1 percent of the women in mental group IV had one or more recorded unauthorized absences, compared to 10.6 percent of the men in mental group I.

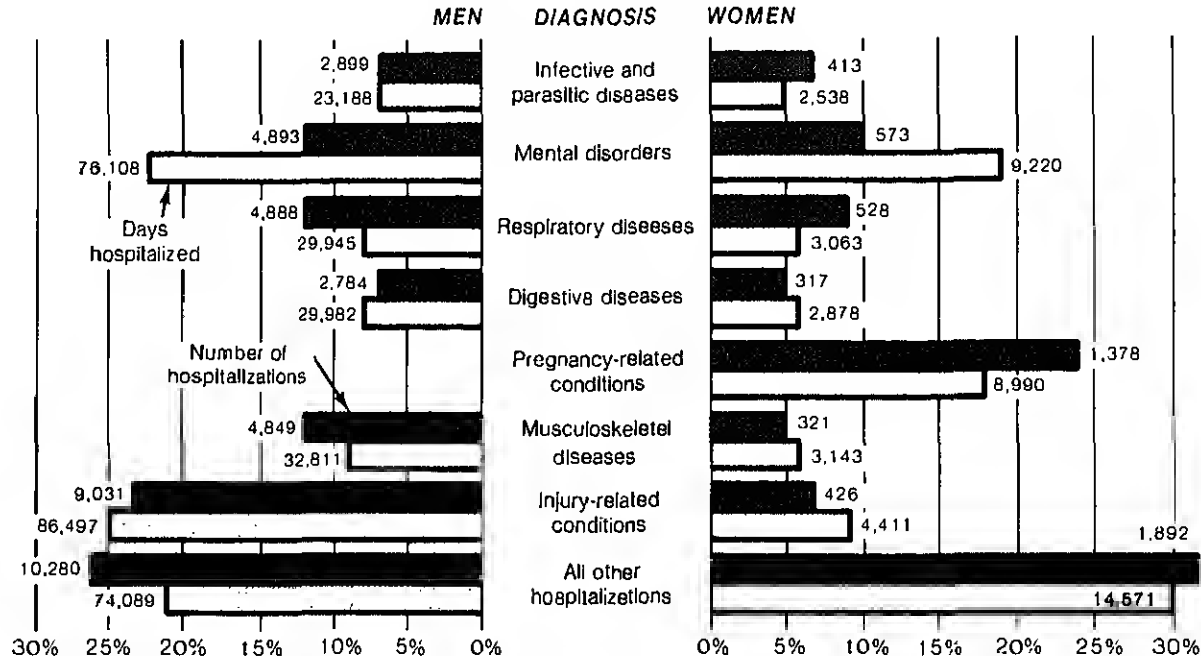
Medical inpatient costs. Authorized absences for medical inpatient care have been very costly for the military, not only in terms of direct hospitalization expenses, but also because of costs associated with disability, retirement, military readiness, and human suffering. For the 1975 group, frequency distributions of numbers of hospitalizations by primary diagnosis and of numbers of days

Unauthorized absences and desertions among the 1975 cohort cost the Navy nearly \$17 million (on average, \$189 per man and \$27 per woman). Overall, women were significantly less prone to such offenses, particularly compared with men in the lower mental categories.



hospitalized were computed by sex for the period from 1975 to 1978 (see Figure 2 on p. 22; data were unavailable for 1979). The rate of hospitalizations for women was more than double that for men.

Men's hospitalizations were most often attributed to injury-related conditions (accidents, poisonings, and violence), musculoskeletal disorders, and mental disorders. These hospitalizations accounted for 47.4 percent of all admissions and totalled 162,605 days, or 46.1 percent of the 352,605 days men lost from duty due to medical inpatient care during the three-year period. Admissions for alcoholism represented 3 percent of all hospitalizations for men and 9,135 days hospitalized; corresponding numbers for drug-related conditions were 281 hospitalizations and 1,386 days hospitalized. Among women, pregnancy-related conditions accounted for the greatest number of



SOURCE: NAVAL HEALTH RESEARCH CENTER

numbered 573 among women, or 9.8 percent of the total, and were the second leading reason for women's hospitalizations. Pregnancy-related conditions and mental disorders amounted to 18.4 percent and 18.9 percent, respectively, of the 48,812 days women lost due to hospitalization during the period under study.

At \$157 per day, overall hospitalization costs for the period from 1975 to 1978 were \$55,358,200 for men and \$7,663,484 for women. Prorated costs were \$624 and \$1,281, respectively.

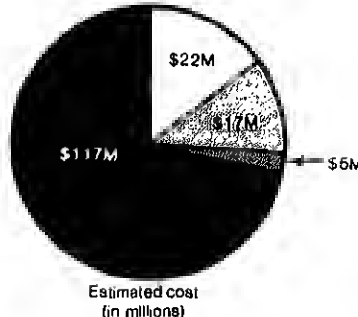
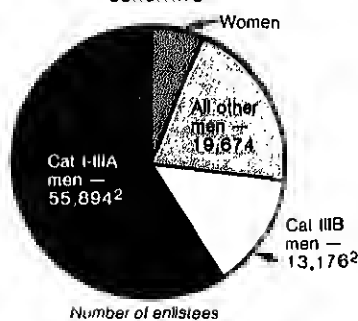
Recruiting costs

According to Huck and Midlam (p. 23), the costs of recruiting an enlistee vary as a function of the quality and the gender of the individual. Unless competition is keen, the Navy does not have to spend money to locate and persuade individuals to

join; in other words, enlistees cost only their prorated share of the recruiting, advertising, and processing budgets. Because high quality people are in greater demand, recruiters must make personal contacts, provide tours of bases, and set up booths at high schools and job fairs in order to attract them. Huck and Midlam found that male high school graduates in the upper mental group categories (categories I-IIIa and category IIIb) cost the Navy \$2,100 and \$1,700, respectively, as opposed to \$875 for all other men and women. Navy recruiting costs in 1975 averaged \$1,769 for each male enlistee and \$875 for each female enlistee (see Figure 3 on p. 23).

Attrition costs

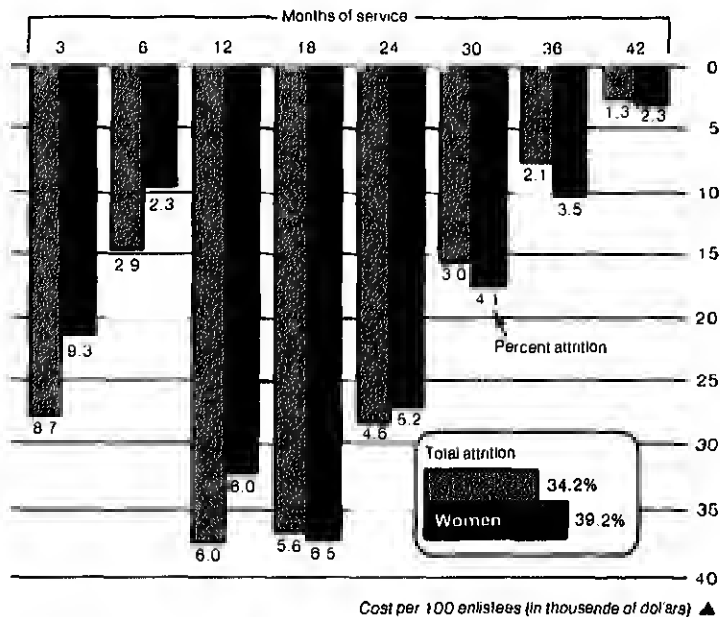
At a time when the number of men eligible for military service is declining, attrition is a particu-



¹ Excludes bonuses for hard-to-fill positions

² Exclusively high school graduates

SOURCES: HUCK AND MIDLAM (1977), GENERAL ACCOUNTING OFFICE (FPCD 78-52), AND NAVAL HEALTH RESEARCH CENTER



larly vexing problem, both because of the recovered investment each loss represents and because of the difficulty in replacing the individual. To estimate the cost of military attrition, Huck and Midlam developed an unrecouped investment curve based on costs incurred at various points during the first enlistment and the extent of training provided. Included, by month of service, were expenses for recruiting and initial processing, basic and advanced training, pay and allowances, medical care, travel, and judicial actions. As shown in Figure 3, the average costs to the Navy for a premature separation vary according to the number of months served; highest costs occurred at 18 months.

In determining attrition costs for women, only the average difference of \$894 in recruiting costs between men (\$1,769) and women (\$875) was subtracted from the figures presented (GAO figures

the large difference between men and women in recruiting costs). In other words, training, pay, and allowance costs were assumed to be identical for both sexes, and the higher travel and judiciary action costs associated with men were assumed to be offset by the greater medical expenses incurred by women.

Comparisons showed that the attrition rate of women in the 1975 cohort was higher than that of men. For every 100 women enlisting, 39 failed to complete four years of service, at a loss of \$158,431; for every 100 men, 34 were separated, for a loss of \$171,745. Reasons for attrition in the 1975 population varied quite dramatically between men and women. Most often—42.6 and 38.4 percent of male and female separations, respectively—both men and women left the military when their term of enlistment expired or upon release

misconduct and undesirable, dishonorable, or bad conduct discharges were much higher for men (8.7 percent vs. 1.7 percent for women).

In terms of overall expenses, each woman cost the Navy an average of \$853 less than if a substitute man had been enlisted. By category, the breakdown in costs for the 1975 cohort was as follows: dependents, including housing, medical, and travel costs, \$1,414 per man and \$960 per woman; unauthorized absences and desertions, \$189 per man and \$27 per woman; medical inpatient care, \$624 per man and \$1,281 per woman; and recruiting, \$1,769 for each man, \$875 for each woman. For the 5,984 women who enlisted in 1975, overall savings to the Navy were \$5,104,352. On balance, attrition among women was somewhat higher than among men, but the lower cost of their initial recruitment offset any loss this difference represented.

Cost effectiveness implications

Results of this study indicate that enlisted Navy women in the 1975 cohort tend to be more cost effective than men for the variables considered. On the average, they have fewer dependents than men and, therefore, represent considerable savings to the organization in dependent-related costs. Also associated with such savings is the fact that more than half of all married military women are married to military men. Dual-career couples share expenses for dependents and, thus, the Navy is spared dependent expenses for one spouse.

As reported above, costs associated with unauthorized absenteeism are seven times greater for men than women, while costs for women's hospital care exceed those for men by almost twice as much. Perhaps as important as the monetary losses involved are the effects of absenteeism on military readiness and on the morale of fellow crew members, who must do both their own work and

workers.

Clearly, the hospitalization rate for pregnancy-related conditions among women is considerably higher than the rate for any specific category among men. However, almost half the pregnancy-related hospitalizations in the 1975 cohort were for abortions, which, since October 1978, may no longer be performed in military hospitals because of a court ruling forbidding expenditure of federal funds for elective abortions. Thus, prorated hospitalization costs for women enlisting after that date are probably much lower than those reported in this analysis. Hospitalization rates for injury-related conditions, on the other hand, are much higher for men than women. As the 1975 cohort matures, total hospitalization rates for women will likely decrease to about half those reported during a first enlistment, if hospitalization rates for this cohort correspond to trends noted in other research.⁷ Also reported in that research is the finding that men's injury-related hospitalizations decline with age, while their admissions for alcoholism increase substantially. Rates for alcoholism-related admissions among women tend to decline across age groups.

The attrition rate of women enlisting in 1975 was somewhat higher than the corresponding rate for men. However, almost equal proportions of men and women stayed in the Navy beyond first-term enlistment (21.1 percent and 19.4 percent, respectively). Thus, the commitment of women to a career in the Navy paralleled that of men, as has been reported elsewhere for a subsample of this population.⁸

Recruiting costs for male high school graduates in mental group categories I to III represent a

⁷ Virginia Adams, "Jane Crow in the Army: Obstacles to Sexual Integration," *Psychology Today*, 14 (1980), pp. 50-65.

⁸ Anne Hoiberg, "Sex and Occupational Differences in Hospitalization Rates among Navy Enlisted Personnel," *Journal of Occupational Medicine*, 22 (1980), pp. 685-90.

⁹ Patricia J. Thomas, Factors Influencing First-term Rec enlistment of Women and Men (San Diego, CA: Navy Personnel Research and Development Center, 1980).

higher probability of performing successfully throughout a first enlistment.⁹ The same studies also show a much lower rate of unauthorized absences and desertions among graduates. The additional expenditures for recruiting male graduates in the upper mental categories, therefore, probably reduces costs associated with premature attrition and unauthorized absences.

Because female high school graduates continue to be interested in enlisting, little active recruitment of this group has been necessary; as a result, the Navy has saved substantial amounts of recruiting and advertising funds.¹⁰ In general, because the services offer women a variety of occupational specialties, various training programs and duty assignments, and equal pay with their male counterparts, women's interest in the military has been high. By way of contrast, 80 percent of all employed women in the civilian sector perform jobs labeled "women's work," low-paying jobs that offer few opportunities for advancement.¹¹ Equal opportunity in the Navy, therefore, has contributed to meeting the goals for increased utilization of women overall and has helped the organization reduce recruitment and unauthorized absence costs. Furthermore, women's hospitalization and attrition costs, particularly those associated with

These results are important as a basis for justifying the enlistment of women to those skeptics who need the substantiation afforded by such research. But the most crucial consideration to the Navy is meeting personnel needs with the most qualified individuals, whether men or women. Given the personnel costs discussed in this study and the costs associated with designing and purchasing equipment, machinery, weaponry, ships, and aircraft—all high-cost items—the Navy cannot afford to enlist individuals who have neither the potential skills nor the values to properly maintain, repair, and operate the organization's hardware. In the near future, therefore, filling quotas will become secondary to attracting high-quality people who will enlist and remain in the Navy. Consequently, the Navy is developing innovative recruiting approaches, effective classification procedures, sound assignment policies, skilled leadership techniques, and improved environmental and work settings. These efforts and the recent increase in military pay should make the Navy a more appealing career option for high-quality men and women.

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⁹ Anne Hoiberg and Newell H. Berry, "There's No Doubt About It, a Diploma Goes a Long Way for Combat Efficiency," *Marine Corps Gazette*, 61 (1977), pp. 57-61; E. K. Eric Gunderson, "Unauthorized Absence, Desertion, and Attrition Rates for First-Term Navy Enlisted: A Twelve-Year Perspective," unpublished manuscript.

¹⁰ Patricia J. Thomas, "Issues in the Management of Women in the Navy," *U.S. Navy Yearbook of Manpower, Personnel and Training*, 1 (1980), pp. 15-22.

¹¹ Anne Hoiberg, "Military Occupations: The Cutting Edge for Women?" paper presented at the American Psychological Association Meetings, Montreal, Canada, September 1980; Anne Hoiberg, ed., *Women and the World of Work*, (New York: Plenum, 1982), in press.

¹² Anne Hoiberg, "Women in the Navy: Performance, Health, and Motherhood," in J. Brown, M. J. Collins, and F. D. Margiotta, eds., *Military Manpower Realities in the 1980s*

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on schedule and within budget

By GEOFF SUTTON

Teamwork, meticulous planning and control, and a determined resistance to the temptations of overengineering can pay off handsomely on a major procurement effort.

Cost overrun—this term and all that it implies has been so synonymous with nearly every major acquisition effort that to many people it labels a disease from which no service and few contractors are immune. Examples abound; less plentiful are exceptions to the rule that all defense procurements must inevitably exceed time and money projections. But such programs do exist, and both the Navy and the Army can point to particularly outstanding examples.

At Bath, Maine, a Navy shipbuilding program is actually experiencing cost *underruns*. Since 1977, Bath Iron Works has been delivering FFG-7-class guided-missile frigates from 4 to 20 weeks ahead of schedule. Better yet, the yard has been completing each ship for an average of some \$5 million less than the \$70 million contract price.

Another success story is the Army's CH-47 Chinook medium-lift helicopter modernization program. This remanufacturing effort will return 436 aging aircraft to zero-time condition, thereby assuring a much-needed airlift capability until the year 2000. Activity began in 1976 and not only has the contractor, the Philadelphia-based Boeing Vertol

but it has earned \$3.5 million in design-to-cost incentive fee awards as well. In fact, during the four-year, full-scale engineering development phase, Boeing captured a superior performance rating and 98 percent of the total amount of incentive fees available.

Sound management practices and strong leadership in both the military and civilian sectors make such results possible. Also essential are positive attitudes and a firm belief that cost and schedule overruns can be prevented by intensive, detailed planning and strict adherence to unchanging work statements. On the Chinook project, both Brig. Gen. James M. Hesson, deputy commander of the U.S. Army Troop Support and Aviation Material Readiness Command in St. Louis, and William P. Jones, Boeing Vertol's director of military programs, had that outlook.

From 1975 to 1979, Brig. Gen. (then Colonel) Hesson was project manager for the CH-47 modernization program. "In management, in design-to-cost, in reliability and maintainability, it's mental attitude that counts," according to Brig. Gen. Hesson. "We had to believe it could be

rallying their respective teams; they visited suppliers, whipping up enthusiasm for their program and asking not only for customary performance but for wholehearted support and money- and time-saving suggestions as well. Later, during regular review sessions at Boeing Vertol, when fifty or sixty Army staff people from various agencies descended upon the plant, these vendors were invited to tell the Army of their progress in the modernization effort, and, if necessary, feel the heat.

Colonel Dewitt T. Irby, Jr., the most recent project manager for the CH-47 in St. Louis, appreciates the importance of having vendors make intelligent, timely, and complete input into the program. Colonel Irby's specialty is logistics and he has experienced firsthand the frustration of working with incomplete and incorrect hardware and software. "I know what the guy in the field needs because I've been there," he said, "and I've received unfit tactical systems before."

John P. Clarke, the Army's deputy project manager, calls attention to the role of strong management in keeping major programs on track: "You need two strong managers—one at the company and one in the Army—who have control over their respective organizations. Bill Jones is a strong manager at Boeing Vertol, and we have our strong managers here."

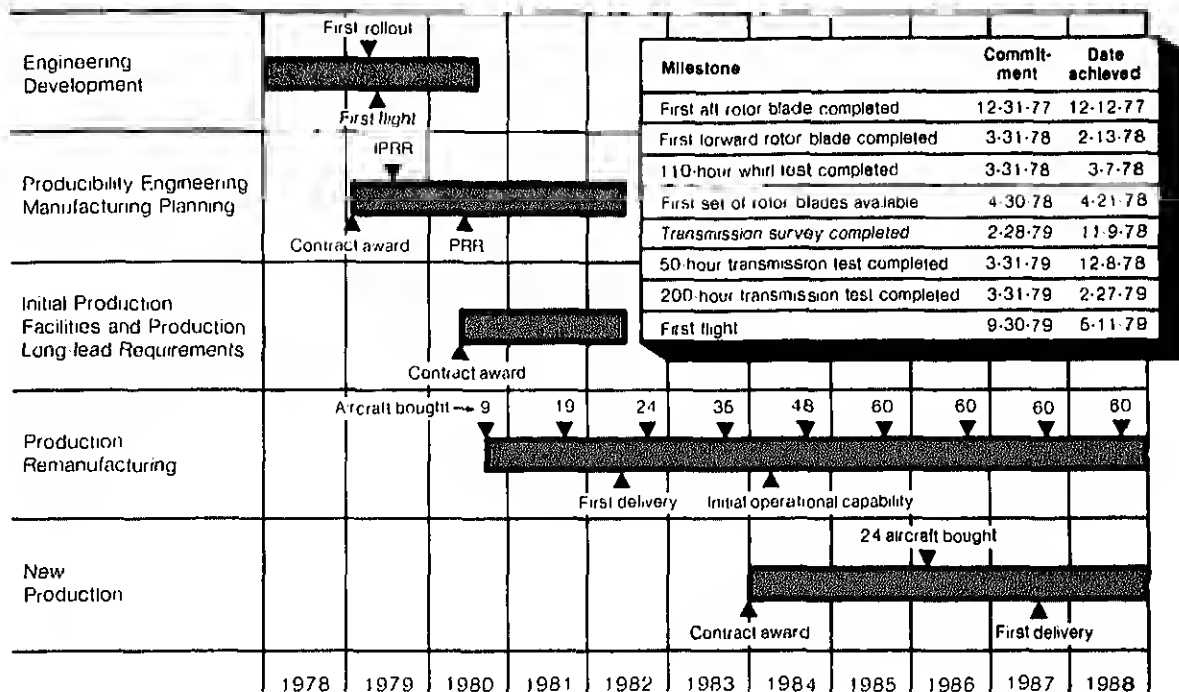
Strong management, however, does not necessarily consist in exercising total, uncompromising control. It is often a matter of setting clear-cut, realistic objectives, informing subordinates in no uncertain terms of what is expected of them, delegating as much authority and responsibility as possible, and constantly auditing the results. In conjunction with careful, detailed planning and some innovative management tools, consistent application of these basic techniques has successfully carried the Chinook modernization program through full-scale engineering development and into production. Following completion of the first production—that is, remanufactured—CH-47D in May 1982, the Army will take delivery of 425

CH-47D are quite specific. On a hot day (95 degrees Fahrenheit and a pressure altitude of 4,000 feet), it must be able to carry a 15,000-pound external load, one way, over a 30-nautical-mile sortie radius. The helicopter must be able to hover out of ground effect for one minute to make the pickup, climb vertically at a rate of 200 feet per minute for one minute, fly to the mission's destination, descend and again hover out of ground effect for one minute, deposit the load, and return to base with its 30-minute fuel reserve intact.

Achieving this lift capability could have been costly and risky had the Army chosen to develop an entirely new medium-lift helicopter. Launching such a 10-year research, development, test and evaluation effort would have cost an estimated \$700 million to \$1.2 billion. For approximately \$500 million to \$900 million less, the Army could modernize its Chinooks by remanufacturing their unlimited-life airframes and upgrading internal and external systems with the latest technology. Put another way, reusing the airframes offered savings of at least \$1 million per ship compared to designing and buying a totally new aircraft.

The potential for overruns and delays on such a project, however, is ever present; it springs from an almost irresistible urge to overengineer. Whether called remanufacturing or modernization, the process presents the opportunity to improve upon improvements without ever stopping. It can be an engineer's dream and a program manager's nightmare, for technology never sleeps; each morning it offers something more desirable than the day before. Dealing with this situation demands decisive management, and in particular, a decision at some point to freeze the configuration—in other words, adopting Brig. Gen. Hesson's motto, "Good enough is good enough."

In the case of the Chinook, remanufacturing became a matter of making the possible happen, an effort that involved a great many people at Boeing Vertol, its suppliers, and Army agencies and commands. The effort got under way in earnest in 1971 when Boeing and the Army looked at various alter-



natives for an aging Chinook fleet, which would shortly need some form of rehabilitation to extend its useful life. Meeting the customer's needs meant modernizing the fleet in order to solve problems that had surfaced in Vietnam. Based on extensive analysis for 750,000 hours of fleet flying—most of which had taken place under combat conditions in Southeast Asia—Boeing's proposal covered some 31 areas and sought both to reduce the cost of ownership and update the Chinook's capabilities. Eventually, the Army and Boeing agreed upon seven major product improvements and joined in an effort to minimize technical risks.

The two principals participated in an advanced development phase in two high-risk areas—drive systems and composite rotor blades. Army gave Boeing a contract for \$3 million on the blades and \$2 million on the transmissions, so that the contractor could take the technical risks out of two im-

program. But rather than offering the customer technology to evaluate after the fact, contractor, and customer worked on this effort together. Boeing thereby avoided the problem of advancing technology in a vacuum and presenting it to the military for their laboratories to evaluate, only to have the scientists report that the risks were too high.

For the rest of the aircraft, Boeing drew upon technology the company had developed under its heavy lift helicopter and utility tactical transport aircraft system programs and applied it to the Chinook. Even though neither of those aircraft went into production, the technology for both had been production-qualified. Thus Boeing was able to propose an aircraft that incorporated the most modern technology in its dynamic components and in its electrical, hydraulic, and control systems—the most critical parts.

and price for that phase took six months. The full-scale engineering development program itself was more than a paperwork exercise. It involved building three prototype CH-47Ds, one converted from an A model, another from a B model, and a third from a C. The objective, of course, was to prove that it was possible to take three similar, yet different, helicopters that had been delivered to the Army in the mid-1960s, remanufacture them incorporating the latest technology, send them out the

cost trade studies. Based on reviews of all high-cost items, such as airframe, hydraulics, and electrical systems, these reports address design and manufacturing alternatives for lowering life cycle costs. Boeing began preparing them for the Chinook after arriving at a configuration for the prototype; it later incorporated the results, once approved by the Army, into the aircraft. The most important thing Boeing did on design-to-cost, according to Stuart D. Dodge, the company's pro-

From models A, B, and C to model D

Boeing's 16-step remanufacturing sequence for converting the CH-47A, B and C models to CH-47D prototypes involved complete disassembly and gutting of the aircraft. Technicians inspected virtually every square inch of surface area and every rivet for corrosion and signs of fatigue. They are following the same basic procedure with the nine helicopters (all A models) currently being remanufactured at Boeing Vertol's main assembly center near Philadelphia under the \$103 million initial production contract. Of course, certain prototyping procedures are no longer required, and some variations occur among aircraft—hidden battle damage, corrosion, or other problems, for example, discovered during disassembly and inspection. Thus, some departures from the following sequence are necessary.

1. Boeing receives the aircraft and its logbooks; drains the ship of fuel, hydraulic fluid, and oil; and purges its fuel tanks. It then removes the rotor blades as well as all troop and cockpit seats and blankets from the ship's interior, and gives the machine a routine depot maintenance inspection.

2. Next, in the case of prototype aircraft, was an engineering review.

3. Removal of components continues; included are the forward rotor head assembly, the aft transmission and rotor buildup, combiner shafts, engine and transmission buildup, combiner and remaining shafts, auxiliary power unit, and blower and shaft.

4. Fuel pods, ramp, fuselage floor beams, and aft pylon come off, as do all hydraulics and electrical

equipment, avionics, controls, and mechanical equipment.

5. Wiring harnesses, cables, tubes, valves, and ducting are removed.

6. Workers thoroughly clean and wash the aircraft (what remains of it).

7. At this point, prototype aircraft underwent engineering design development, which included preparation and detail designs, assembly and installation drawings, and liaison with manufacturing.

8. Disassembly resumes—all doors, hatches, glass, drive-shaft covers, the forward pylon and aft fairings are taken off.

9. Following removal of landing gear, CH-47B and C airframes proceed to structural modification, as do A-model fuselages, after being separated into three sections.

10. Modifications continue, after which the landing gear is reinstalled, the airframe partially instrumented for flight testing, and A-model fuselages spliced.

11. Workers install the transmissions and hydraulic, electrical, and drive-system components.

12. Engineering, quality assurance, and manufacturing teams review system installations.

13. Electrical, hydraulic, pneumatic, and lubrication systems are installed.

14. All doors, pods, the ramp, glass, fairings, and tail cone are installed and final instrumentation completed.

15. After being painted, the aircraft undergoes function and preflight tests.

16. The helicopter is flight tested.

essentially the study results and the hardware planned for production."

If the prototypes proved to have good reliability and maintainability characteristics, then the production aircraft would have them too. These features were quite important to the Army because, as Dodge explained, three-quarters of the cost of a system comes after the point of initial operational capability, when the aircraft are in the field; only one-quarter is acquisition. The incentive award fees offered by the Army during the development program bore this out. Of the four awards over the four-year period, 53 percent, or \$1,853,000 of the \$3,524,800 earned overall, related to the proposal for the first nine production aircraft. In other words, the incentive fee structure rewarded Boeing's ability to build an effective configuration and bridge the cost between the prototype aircraft and the production machines. It was to Boeing's advantage to fix any problems with the prototype before going to production.

The Army used award fees very carefully. In the early stages of the program, the purpose of the incentive was to encourage the contractor to use design-to-cost trade studies in developing the prototypes. The Army placed a series of worthwhile targets in front of Boeing, and if the company didn't win all or nearly all of an award, a rollover provision in the contract permitted the funds remaining from one award period to be added to those in the succeeding period. Also worth noting, as Brig. Gen. Hesson observed, "is that award fees are totally judgmental and not subject to reclama. They require people on both sides of the fence to be totally objective, honest and professionally moral."

While \$3.5 million in award fees are not to be dismissed lightly, neither do they represent overwhelming amounts of money. The awards did their job of directing attention to suspected problem areas, but were only part of a much broader effort to collect data and control costs through pre-planning. In fact, one often overlooked payoff in design-to-cost studies is that the discipline forces

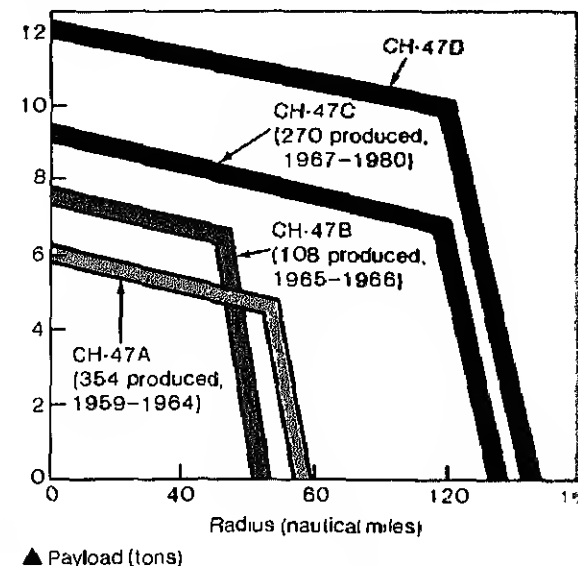
this data base, Army cost teams audited it. "We sell a lot of helicopters to a lot of people," Starnes Dodge noted, "and this is the only program with a data base this extensive. After building nearly 1,000 Chinooks for 14 different nations, we've never been this well organized going into a production program."

Also instrumental in fostering a disciplined and comprehensive approach to planning was the cost and schedule control system Boeing implemented. For each segment of a project, the system required documented decisions about what would be done, who would do it, when, and for how much. In other words, it forced everyone involved in the development effort to plan, allocate resources to that plan, and keep track of the results. Commitment in advance to specified goals and milestones encouraged adherence to the plan.

In addition to building a data base and developing

From model A to model D

The CH-47 modernization effort will make the earlier models of the Chinook more reliable, less costly to maintain, and much more capable.



mine key events necessary to make the master schedule happen. The analysis showed a production program that would consist of some 11,800 events. Boeing loaded all of these events into a computer, which once a week kicked out events that were done and those that weren't, so that the company could monitor exceptions and ask the right questions to find out what the problems were. If estimated completion dates were close to schedule, program managers didn't have to worry about them; if they were two months off, then managers could start planning a workaround. Again, it's the discipline enforced by such a process that's so important.

Boeing found that one of the keys to effective use of these design-to-cost management tools was a rule, made early on, forbidding changes in the rules; in other words, at a point in time, the company froze everything. In 1975, according to program manager Stuart Dodge, the manufacturer froze the configuration, the business base, and the indirect factors that go into costing; only material prices and labor content were excepted. Especially critical was the freezing of the configuration. Neither the Army nor Boeing would permit changes to the production design unless written into the contract, and that system worked. In fact, the only two major changes in production design were in the fuel system and in the avionics. The former allowed Boeing to take advantage of single-point pressure refueling that pushed 1,000 gallons in only three minutes, compared to the old method of refueling 1,000 gallons in 25 minutes; the latter was necessary because manufacturers had discontinued some of the old avionics.

While the rule prohibiting changes to the development plan or the configuration obviously contributed to keeping on cost and on schedule, another technique—establishing both cost and time reserves—paid off handsomely as well. By limiting its Chinook staff to 90 percent of the schedule and budget actually available, Boeing in effect set aside time and money. The company in fact had a 40-m schedule b t req red its f c i n l denart-

such rebuilding extended aircraft life and enhanced capabilities, often at great savings to the owners. Occasionally civilian craft, or at least parts of them, even find their way into military service. Last fall, for example, Boeing Military Airplane Company acquired 18 surplus Boeing 707-100Bs from American Airlines and plans to use components from them in modernizing KC-135 tankers under a \$62.6 million contract with the Air Force.

When budget cuts thwart plans for new aircraft, the services can fall back on modernization to fulfill future mission needs with older but upgraded aircraft. In late September 1981, for example, Bell Helicopter Textron, Fort Worth, Texas, received a \$148 million research and development contract from the Army that includes production of five prototype near-term Scout helicopters. This modification program, established in lieu of a totally new Advanced Scout helicopter, could bring as many as 720 OH-58A light observation helicopters up to near-term Scout standards. The upgraded OH-58As are to include new and more powerful engines and transmissions and advanced rotor systems and avionics. Installed power is to increase to 850 shaft horsepower from 317 shp, main rotor blades to four from two, and gross weight to 4,500 pounds from 3,000 pounds. In the cockpit, cathode-ray tubes will display navigation information and target acquisition data, the latter provided by a new mast-mounted sight.

In a project similar to Boeing Vertol's CH-47D modernization program, Grumman Aerospace Corporation is remanufacturing OV-1B and OV-1C Mohawk twin-turboprop aircraft to OV-1D and RV-1D configurations at its facility in Stuart, Florida. Grumman built 380 Mohawks from 1960 to 1970, of which 218 remain today. The Army needs 146 OV-1D and RV-1D airplanes to serve in active and reserve components until the year 2000. The remanufacturing process involves removing the wings, engines, tail surfaces, nose sections, wiring, and landing gear for complete inspection and repair as necessary. Grumman then installs new wiring, landing gear, and engine mounts and modifies the aircraft to bring it up to D-model standards. The entire process takes 11 to 12 months and requires about 16,000 man-hours to convert an OV-1C to OV-1D configuration and about 20,000 man-hours to convert a C-model Mohawk to RV-1D standards. The completed aircraft roll out as new zero-time machines.

into that research and development contract, Boeing still had a plus reserve.

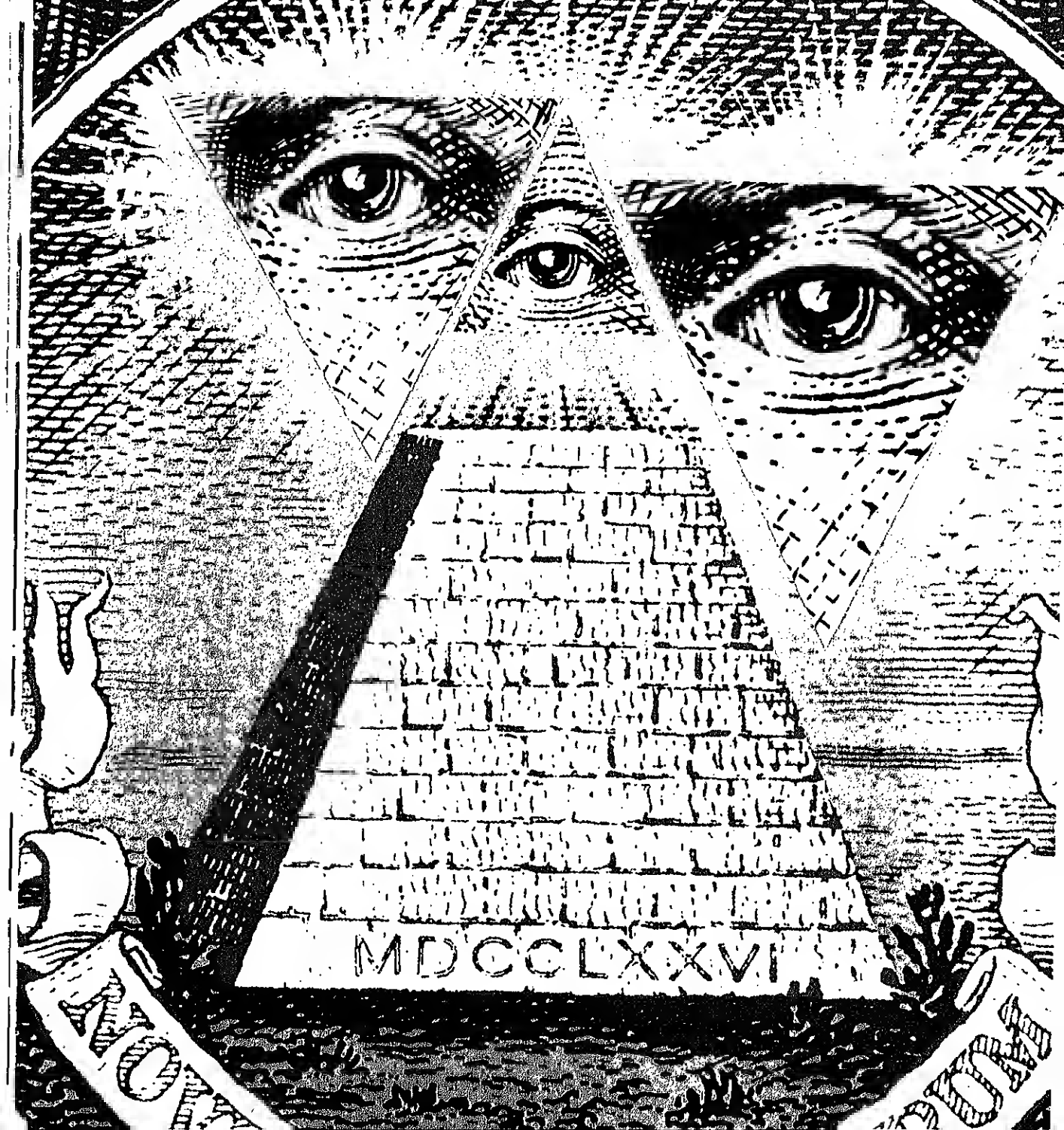
Those responsible for the remanufacturing effort also attributed a large portion of the program's success to the people involved, the way they were organized, and the way they interacted with each other and with the Army. Autonomous program management operations typically involve a program manager who has a chief engineer, a director of factory operations, a material representative, a contracts negotiator, and others working directly for him. He takes the best people from various functional departments, serves as their supervisor, and then tries to direct his program amid the mainstream of other product activity. Instead of taking this approach, Bill Jones adopted a team concept of program management; he organized a staff drawn from various disciplines—engineering, procurement, quality, planning, and tooling—into a matrix structure, with the program manager functioning as leader of the team. The approach worked so well that all staff members who were part of the original team either advanced in the company or went on to executive positions with other firms.

Those associated with the CH-47D effort can point to many successes, but the program was not without problems. When they surfaced, however, the project's ongoing and extensive record keeping, coupled with management flexibility, allowed for timely solutions. Brig. Gen. Hesson recalled, for example, when serious difficulty in redesigning the Chinook's hydraulic system threatened dire consequences for the budget. Because the weekly forecasts alerted management to the difficulty, Boeing was able to respond quickly with a major personnel shift in the hydraulics design group. The hydraulics redesign effort proved a major project that would have a positive impact in reducing operating costs due to its vastly increased simplicity: the number of hoses and tubes alone were reduced from 520 to 140, and the number of leak points slashed from 1,040 to only 219!

whelming. "Bad news never gets better with age," he observed. Similarly, Bill Jones spoke of his company's open-door policy with pride. He called attention to Boeing's weekly management control meetings, in which customer representatives participated fully; they took part when the project was in trouble and when the company was meeting all its commitments, and they joined with Boeing in developing workarounds to avoid major delays in the program and cost overruns.

The Army and Boeing agreed that this willingness to communicate openly and often, like the positive attitude of those working on the program, contributed greatly to the success of the project. Subjective factors such as these are less easy to quantify but were no less important to the Chinook modernization program than the award fee concept or management tools such as design-to-cost trade studies, the cost and schedule control system, and the document of industrial engineering. Set within the right management environment—one that stressed meticulous planning and control and appreciated the dangers of overengineering—they helped keep the Chinook remanufacturing effort on time and on schedule, no mean feat in an era when overruns seem to be the rule rather than the exception. **DMJ**

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MDCCLXXVI

The associate contractor strategy for systems acquisition

By *LIEUTENANT COLONEL WILLIAM F. MOORE, USAF*

The associate contractor strategy allows the government to participate more directly and fully in systems acquisition management; it has already proven an effective technique in acquiring major Air Force weapons systems.

A critical step in effectively managing the acquisition of any major system is the development of a comprehensive acquisition strategy, a requirement imposed upon all federal agencies by Office of Management and Budget Circular Number A-109. Clarification of this requirement is contained in Office of Federal Procurement Policy Pamphlet Number 1, which specifically directs that agencies consider system or product development, especially maintaining a proper risk-sharing relationship between the government and contractors; business management, with emphasis on the need for obtaining and sustaining competition; and program management, or selecting a proper organizational mode for project management. Using comprehensive acquisition strategies that integrate these concepts is clearly a prerequisite for successful management. This paper offers both a theoretical and a practical rationale for increased use of one such highly effective, but managerially challenging strategy—the associate contractor structure.

Typically, a government program office, whether prime contractor is free to award subcontracts as he sees fit, but remains accountable to the government for completing the whole job. Decisions on how much of the task to accomplish in-house, how much to subcontract, and how much competition to promote among subcontractors are the prime contractor's to make. The government is essentially a spectator rather than a participant in these decisions.

The Air Force's Aeronautical Systems Division used the prime contractor strategy on several major aircraft development programs during late 1960s and 1970s, including the C-5A, F-16, F-15, and B-1. Derivatives and modifications to the basic strategy are frequent. In developing aircraft, for instance, the Air Force usually relies on at least two prime contractors, one for the airframe and one for the engines. Similarly, for a major program, the Air Force may award more than one prime contract during the development phase to permit a competitive fly-off evaluation. In each case, however, the generic characteristic of the prime con-

On the other hand, the primary distinguishing characteristic is the use of several relatively small contracts with an array of associate contractors, instead of one contract with a single, large prime contractor. Under such an acquisition strategy, the government retains overall responsibility for integrating deliverables from the associate contractors into a functional system, a major responsibility that obviously increases managerial workloads.

Again, derivatives of the basic strategy are possible and often desirable. Even though no single contractor has total integration responsibility, a large, systems-oriented subcontractor is often in charge of broad tasks such as assembly, test, and system support. In this role, the contractor has major responsibilities, including early identification and elimination of interface and integration difficulties. Even under such a derivative, however, the primary distinguishing characteristic of the strategy remains; only the government has authority to require action on the part of an associate contractor. The acquisition agency retains ultimate responsibility for the total weapon system rather than delegating it to a prime contractor.

In the Air Force, the Ballistic Missile Office is the primary acquisition agency that has used the associate contractor structure. On its two largest Intercontinental Ballistic Missile programs, Minuteman and M-X, the office has consistently been able to exercise important management prerogatives that simply would not have been available through a prime contractor.

The prime contractor strategy

The prime contractor relationship has relatively obvious strengths and weaknesses. Discussion of these will be brief, since the purpose of this article is to emphasize the advantages of the less familiar associate structure. But because the strategies are virtually philosophical opposites, knowledge of the one almost necessarily entails knowledge of the other. An appreciation of the advantages of either one implies an understanding of the disadvantages

of the other. On the other hand, a separate contract for each propulsion of an Intercontinental Ballistic Missile is logical. Practicality must always be the pre-criterion for the selection of any acquisition strategy.

Another advantage of the prime contractor strategy derives from its managerial simplicity. In a particularly complex program, the government may be technically or managerially incapable of assuming the integration task. Theoretically, the prime contractor structure, under which the contractor takes on this task, solves the problem in the process, allows significant government power efficiencies. With total integration and contractor selection responsibilities passed to the prime contractor, the government program office should be a relatively small organization. However, a cursory analysis of the manpower allocation for major aircraft programs managed under the prime contractor structure does not support this theoretical advantage. On such projects, the government cannot afford to be disinterested in major program decisions made by the prime contractor. Even though contractually delegated the authority for making these decisions, the program office elects to monitor contractor management so closely that power requirements remain the same. With the same number of personnel, however, the government could have assumed a significantly more active management role.

The prime contractor strategy can also be advantageous in dealing with management restrictions that often are imposed on government procurement actions. When short time constraints and critical delivery requirements apply, for example, the prudent course of action may be to recognize the relative efficiency with which a prime contractor can award and enforce subcontracts. In some cases, a conflict between government lead time and schedule requirements sometimes does not justify the use of the associate contractor strategy. Under severe constraints, the government may be fortunate in being able to award a single contract

freedom cuts both ways. The contractor often achieves efficiencies at the expense of overusing sister divisions within the same corporate entity.

An extreme approach to the prime or single contractor strategy can have undesirable results. The classic example of such an approach is the total package procurement concept used on the C-5A program. The government awarded a single contract for both development and production of the C-5A aircraft; however, the results of this strategy were so disastrous that the Defense Acquisition Regulations now specifically prohibit total package procurement.

The associate contractor strategy

An associate contractor structure has several distinct advantages when applied to a major weapon system development or acquisition program. Many of the practical managerial advantages are relatively apparent, but they result directly from a less apparent theoretical concept of risk reduction as an inducement for contractor cost control. As noted earlier, maintaining a proper risk-sharing relationship between the government and its contractors is one of the major components of sound acquisition strategy. To fully appreciate the practical benefits of an associate structure, one must have some understanding of the theoretical foundation on which many of them are based.

Each year, a very large percentage of the contracts awarded by the Department of Defense contain cost-incentive provisions which make a contractor's profit dependent on his willingness and ability to control costs. Research shows, however, that these incentive provisions are in many cases totally ineffective in motivating contractor cost control.¹ By assuming that contractors behave as rational profit maximizers—the assumption implicit in extensive use of cost-incentive provi-

tracts, even though these provisions do not maximize their expected profit. Such behavior is characteristic of the classic risk averter. Contractors typically negotiate for contract types (cost-plus rather than firm-fixed-price) and cost-incentive sharing fractions (small rather than large) that reduce their exposure to loss rather than maximize their expected profit.

The same kind of behavior continues after contract award. Rather than managing expenditures as incentive provisions suggest that they should, contractors behave as if dominated by other determinants. Studies show that each of the following factors significantly influences their behavior:

- Contractors perceive a direct relationship between present efforts to reduce costs and loss of future profits. They realize that technology developed under current government and commercial projects often has direct application to later efforts. In other words, to the extent that a contractor skimps on initial research to obtain very minimal additional profits, he may be sacrificing significant future profits and competitive advantages.²

- Taxes on marginal changes in a contractor's total annual profit effectively reduce the value of most negotiated cost-sharing coefficients by half. Therefore, when overruns lower a contractor's profits, the government actually bears half the reduction because it in turn lowers his tax liability.³

- The uncontrollable cost components of a contract may totally dominate those that are controllable.⁴ Therefore, maximum effort to reduce controllable costs may still result in savings that are insignificant relative to the contractor's total risk. Such a contract is essentially a lottery with unknown, short-term profit and loss probabilities. The contractor will orient his negotiation and

¹ Sherer, pp. 262 and 275.

² J. R. Fox, *Arming America: How the U.S. Buys Weapons* (Cambridge: Harvard University Press, 1974).

³ C. Bradley and C. McCuiston, "The Rationale for Incentive Contracting," *Defense Science and Technology*, 1973.

⁴ F. M. Sherer, "The Theory of Contractual Incentives for Cost Reduction," *Quarterly Journal of Economics*, May 1973.

Given the influence of these factors, it follows that government incentive contracts often fail to motivate contractor cost-reduction efforts for the simple reason that contractors have more important things to worry about. To be effective, incentive provisions require a contract structure that eliminates the fixation of contractors on risk exposure, thereby freeing them to assume the role of profit maximizer. The associate contractor strategy, with its basis in modern utility theory, provides such a structure.

A couple examples will help establish the basics of that theory. One fundamental tenet is that attitude toward risk determines the investment decisions a person makes. Most rational individuals would readily choose to play in a coin flip if they could win two dollars each time heads came up, but only lose one dollar on tails. Expressed mathematically, this opportunity has a positive expected value of $.5(\$2.00) - .5(\$1.00) = 50¢$, and rational profit maximizers would willingly invest up to 50¢ to play. In such situations, with insignificant profit and loss potentials, expected value is the appropriate decision criterion.

But the decision becomes significantly more complex when only the payoffs change. Predicting the choice rational individuals or corporations would make if they won \$200,000 with heads, but lost \$100,000 with tails is not as easy. Because of the probability of losing \$100,000 or having to mortgage future earnings to that extent, fewer people would be willing to play. The expected value of this game is \$50,000, but expected value is no longer the appropriate decision criterion. Instead, risk-aversion attitudes dominate. After adjusting possible outcomes for risk, the individual perceives that this game has a negative "real" value, and he is unwilling to play. To negotiate effective incentive contracts, government representatives must understand how defense contractors apply this risk-adjustment process.

Several methods are available to approximate the way in which risk is actually incorporated into a decision process. They generally involve estab-

tion from receiving \$10,000; the pauper derives a very full measure. The amount of money is the same in each instance, but the utility is very different.

For most decision makers, the utility relationship can be expressed as an exponential function.⁵ Very tractable mathematical formulas, derived from this function, make it possible to compute the risk-adjusted value of uncertain ventures. Risk-adjusted value, of course, depends on the decision maker's attitude toward risk, his risk-aversion level.

Academic research shows conclusively that breaking any large, risky venture into several smaller parts—each at a separate price and with separate profit and loss probabilities—reduces overall risk and increases the risk-adjusted value of the total venture.⁶ This finding is of special significance to government contracting agencies, which always have the prerogative of deciding which type of contract strategy is appropriate for a particular effort. They can issue a single, large contract to one prime contractor and take the chance that his risk-adjusted value is small enough to render the contract's profit-incentive provisions irrelevant. Or they can subdivide the effort and award several smaller contracts, thereby increasing the total risk-adjusted value to the participants. The government can apply this same subdivision mechanism in a sole-source situation by breaking the total effort into several independent stages.

Reducing contractor risk exposure through the simple method of contract subdivision thus encourages defense contractors to be more cost-conscious, and the cost incentives in any contract grow in importance. Under such a contract strategy, risk-aversion attitudes are less likely to dominate contractors' thinking. The associate

⁵ S. K. Gupta and J. M. Cozzolino, *Fundamentals of Operation Research for Management* (San Francisco: Holden Day, 1975), pp. 231-64.

⁶ J. M. Cozzolino and D. K. Ghandi, "A Strategy for

This sound theoretical basis is the dominant principle governing many major industrial decisions in oil exploration, insurance, and other risky ventures. Many of the practical and more obvious advantages of the associate contractor strategy derive directly from it. It is of major significance that the associate strategy provides a much more flexible and effective basis for establishing sound risk management and risk-sharing relationships. As noted earlier, these features are critically important in developing an effective acquisition strategy.

Practical considerations

When it chooses an associate contractor structure for a major weapon system acquisition program, the government is able to exercise a whole range of management prerogatives usually relinquished under a prime contractor strategy. Many of these are interrelated, and indeed their synergism, rather than their individual importance, contributes most to the effectiveness of the associate structure. Basically, however, the prerogatives are of two kinds, those that help increase management flexibility and control and those that help preserve competition and reduce risk.

A primary advantage of the associate strategy is that it allows the government acquisition agency to select the most appropriate type of contract for each major component of a weapon system. This option is important because each component may be characterized by totally different technical and cost risk factors. To use the Intercontinental Ballistic Missile example again, a cost-plus-fee contract may be appropriate for a new advanced guidance system, while a firm-fixed-price contract may be most suitable for a low-risk propulsion stage very similar to one already produced. Similarly, each contractor's cost, schedule, and performance incentives can be individually and independently tailored. These important prerogatives are available to acquisition agencies only with an associate contractor strategy.

Another significant advantage is the ability to

criterion for selection is often profitability.

Associate contractor interfaces, established early in the development program, give the government another important management option. At each interface, two sets of expertise are constantly maintained. Contractor A must be familiar with what contractor B is doing, and vice versa, or the AB interface will not work properly. The government can take advantage of this situation to elicit superior performance from both A and B. In the early stages of development, completely specifying every task required to deploy a major weapon system is impossible; therefore, program officials must later add, delete, and modify many tasks. When at least two contractors are technically capable of accomplishing such tasks, the government usually has the ability to allocate additional or newly defined work to the best qualified contractors. The contractors are aware of this government prerogative, and it therefore constitutes a strong incentive for good performance early in the program. On several occasions during the Minuteman development phase, for example, the Ballistic Missile Office reallocated major tasks across an interface, taking from one associate and giving to another, based on performance. The office was able to reassign technical tasks as diverse as a missile stage rocket motor, an airborne guidance computer, and an installation and checkout task for a new command and control system.

Just as the expertise of subsystem associate contractors overlaps, the government acquisition agency itself becomes the source of considerable expertise. The nature of the associate contractor structure requires that the acquisition agency develop a strong technical and managerial team at the system level. With a prime contractor strategy, the prime contractor has this expertise and, by virtue of that fact, becomes a necessary and expensive team member for any future modification program. Only under an associate strategy, because of the program office expertise it provides, can the government deal directly and independently with subcontractors on future modification programs.

consequently, cost and manpower performance reports under cost and schedule control systems criteria and other management systems are more timely, relevant, and accurate. The government is aware of potential problems earlier and can move to reduce or eliminate them more efficiently. In addition, the government avoids a fee-on-fee situation. It works directly with the subcontractors and therefore does not have to pay a prime contractor profit based in part on profit the prime pays his subcontractors. An associate structure thus eliminates one level of profit.

Perhaps the most important practical advantage of the associate contractor strategy is that it permits much greater use of competition. The acquisition agency can compete as many or as few subsystems as it deems appropriate. Several contractors may be qualified to bid on one or more subsystems, and smaller contractors, unable to assume the financial risk of a prime contract, can perhaps compete for a particular subsystem. Because of the overlapping expertise at each interface, as discussed above, the acquisition agency also usually has at least two qualified sources for follow-up work. Multiple sources are especially important when a numerically large acquisition, in which price competition can be very effective, follows a development program. On the M-X program, competition was preserved with the associate contractor approach on each major missile component until the Ballistic Missile Office had evaluated, analyzed, and tested the technical alternatives. Only then were the subsystems integrated into a competitively awarded associate contractor structure.

For particularly risky subsystems, the government may also elect to contract with more than one source and subsequently select a winner. The competition at a subsystem level should be contrasted with the total system "fly-off" concept as applied under a prime contractor strategy. On many programs, funding constraints make a total system "fly-off" impossible, but subsystem competition through the prototype phase may be both affordable and prudent. Again, choice in the matter of

than does a prime contractor structure. Both quantitatively and qualitatively, manpower requirements are more critical. Assuming responsibility for system integration imposes major managerial burdens; government personnel must manage, not monitor. They must know their jobs and do them well. Configuration management, specification control, and interface management, as well as synchronization of schedules and deliveries, are all the responsibility of government middle managers, not the prime contractor. The whole acquisition strategy is simply more complex; several relatively small contracts are much harder to manage than one large one.

Still, the advantages predominate, and the associate strategy offers a practical and effective alternative to the more commonly used prime contractor structures. It has a sound mathematical basis in modern utility and risk management theory and gives the government greater flexibility and control in managing major acquisition programs. Associate structures emphasize risk sharing and the preservation of competition, both of which are critical to effective and efficient management. The strategy represents a proven, innovative approach to modern systems acquisition and, though not appropriate to every program, one that deserves more widespread use. **DMJ**

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federal spending

By RANDY L. BRIGGS

Although the defense portion of the federal budget has been an important tool for implementing fiscal control, new policies could change that situation in the near future.

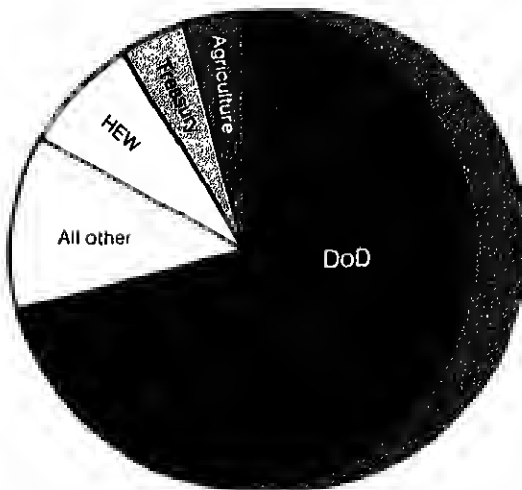
The defense portion of the federal budget is a significant factor in the nation's socio-economic environment. In fiscal year 1981, for example, the Department of Defense employed 892,600 military personnel and support civilians; this figure accounted for nearly half of all federal employees for that year. In addition, defense-related industries employed another estimated 1.5 million workers, further underscoring the important role that defense funding levels play in our economy. Not only does the defense budget affect the size of the nation's total work force and help determine the rate of employment, it is also a powerful tool for implementing fiscal control and stabilizing the economy. This article will explain why defense spending can be an effective discretionary tool in fiscal matters and will consider the effect of multiyear procurement on the budgetary leverage that defense expenditures provide.

During inflationary periods, conflicting requirements often limit the effectiveness or ap-

Control of federal outlays in FY 1980

Of the total budget outlays for fiscal year 1980, 74 percent were relatively uncontrollable—that is, program levels were determined by existing statutes, contractual requirements, or other obligations. However, defense expenditures accounted for only 8 percent of these uncontrollable outlays; accordingly, the defense budget has been the main tool used by Congress to implement discretionary fiscal policy.

**DISTRIBUTION OF
CONTROLLABLE OUTLAYS**



**RELATIVELY UNCONTROLLABLE OUTLAYS
(in billions of dollars)**

	Jan. 1978 estimate	Actual cost	Change
Social security & railroad retirement	120.3	121.8	↑ 1.5
Federal employees — retirement & insurance ¹	33.0	34.7	↑ 1.8
Unemployment assistance	12.4	18.0	↑ 5.6
Medical care	46.2	49.0	↑ 2.8
Student assistance ^{1,2}	3.3	3.9	↑ 0.6
Housing assistance	5.1	6.4	↑ 0.2
Food & nutrition assistance ^{1,2}	10.3	13.2	↑ 2.9
Public assistance ¹	19.0	18.8	↓ 0.4
Other payments for individuals ¹	2.5	3.1	↑ 0.6
Net interest	46.2	52.5	↑ 6.3
General revenue sharing	6.9	6.8	↓ .1
Farm price supports	2.8	2.9	↑ 0.1
Other open-ended programs & fixed costs ¹	10.0	13.1	↑ 3.0
Prior-year obligations — national defense	37.1	38.6	↑ 0.6
Prior-year obligations — civilian programs	50.7	50.0	↓ 0.3
	405.7	439.4	↑ 33.6

* \$50 million or less

¹ Adjusted for reclassifications in the 1981 budget

² Contains programs previously classified as controllable

duced spending can be an effective and attractive alternative in combatting inflation. By cutting back on its own expenditures, the federal government can induce a contractionary effect on the economy, which results in lower production output and reduced employment. Conversely, by increasing its purchases, the government can create an expansionary effect, that results in increased employment and production output, if there is slack in the economy. If the economy is at or near full employment, however, accelerated spending will cause price increases and inflation. Overall, relatively small changes in government spending can greatly affect the economy. By adjusting expenditure levels and applying tax levels, the federal government can influence the economy.

the federal budget, even without taking into account the “multiplier effect” of the defense dollar. In any budget, outlays for a given year are viewed as relatively uncontrollable when a program level is based on existing statutes, contractual requirements, or other legal obligations. The bulk of civilian programs, unlike those in defense, are relatively uncontrollable because their appropriated funds cannot be reapportioned, reduced, or eliminated without amending legislation.

So-called “uncontrollable” outlays are grouped into two major categories:

- Open-ended programs, for which expenditures are generally mandated by law.

first or second category, have a "lock-in" effect on expenditures that effectively precludes implementing fiscal control and discretionary changes. An example will help clarify the implications for a given budget.

Of some \$356.4 billion in controllable funds in the FY 1980 budget, nondefense expenditures accounted for only \$100.8 billion, or 28 percent of all such funds. Total budget outlays for that same fiscal year were approximately 74 percent uncontrollable, of which the defense portion, however, amounted to only 8 percent. With this kind of discretionary latitude, it is not surprising that when Congress responds to public pressure to economize, it often does so by squeezing military spending. Traditionally, as in the case of the FY 1980 budget, no other portion of the federal budget has compared to defense expenditures in terms of controllability. This situation may change, however.

In FY 1981, open-ended, relatively uncontrollable nondefense outlays comprised approximately 59 percent of the total federal budget. Although this figure is expected to decline to 55 percent by 1985, by then the defense budget may not be as serviceable a fiscal tool as it has been in the past. During this same period of time, projected increases in uncontrollable defense outlays are likely to increase the 55 percent total for all uncontrollable outlays by an additional 15 to 18 percent.

An important new element that will affect use of the defense budget as a fiscal tool is the anticipated increase in multiyear contracting. Briefly, the Defense Acquisition Regulations describe this technique as a method of acquiring DoD planned requirements for up to a five-year period without having total funds available at the time of award. While numerous benefits accrue from this procurement technique—lower costs, greater competition, and improved products, among them—it has some mild concern for budgetmakers. By increasing the number of prior-year defense contracts, the unfunded portion of multiyear contracts adds in small measure to the uncontrollable outlays in the federal budget. To this extent, multiyear contracts

subject to section 810 of Public Law 94-166 (implemented in the Defense Acquisition Regulation), which imposed a cancellation ceiling of \$5 million. Section 909 of Public Law 97-86 repealed the previous statutory prohibition, provided a statutory base for multiyear contracting, and required notification of any multiyear contract with a cancellation ceiling of \$100 million or more. Since DoD is fully funding multiyear contracts, except for nonrecurring costs that have been nominal in amount, cancellation will have little budget effect. Selection of only stable programs for multiyear contracting will assure minimal risk of cancellation. However, concern over multiyear contracting persists.

Members of Congress, for example, are questioning the desirability of fencing in defense dollars and the advisability of foregoing annual reviews of particular appropriations. Similarly, budget planners and program and management analysts are recognizing that decisions concerning commitments for long-term weapon programs may limit certain discretion in future budgets. Is this limit on discretionary funding prudent in exchange for potentially more efficient and effective expenditure of defense dollars?

However this issue is resolved, commitments to long-term defense programs will tend to limit discretionary funding of the defense budget, but much less than the effect social programs now have on the federal budget. The potential shifting of funds from the controllable to the uncontrollable side would not approach nondefense levels; but it would make the defense budget a somewhat less pliable tool for implementing discretionary fiscal policy. **DMJ**

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DoD plans for metrics

By GARY R. DILLARD

The Defense Department has gone beyond acknowledging the merits of metric conversion; it is developing plans' and implementing procedures to assure a smooth changeover from the inch-pound system of measurement.

Every industrialized nation in the world is now either using or converting to the metric system of measurement. In the United States, the metric system has been an authorized measurement system since 1866, but only recently has Congress committed the nation to a policy of conversion. Our country is shifting to the system, albeit slowly, in order to be able to better compete in the world marketplace and to enhance the allied defense posture. The implications of conversion for the nation's defense are far-reaching, and this article will consider some of those implications, the Defense Department's pivotal role in the conversion process, and the status of the process in key areas.

The metric system was an issue in the United States long before the 1866 law authorizing its use. Secretary of State John Quincy Adams, tasked by Congress to investigate the need for standardizing weights and measures, endorsed adoption of the system in 1821. Congress has discussed the merits of voluntary, mandatory, or some form of incentivized conversion ever since. In 1975, it officially sanctioned voluntary conversion when it passed the Metric Conversion Act; this legislation represents the first national commitment to convert to the metric system.

In accordance with the 1975 law, the Defense Department is not mandating industry conversion.

has the capability to design, develop, test, and produce systems in metric units. Though the changeover will be gradual, it will affect all DoD operations, systems, and procedures and every DoD employee, from the clerk working with different-sized paper to the program manager developing metric hardware. As one might expect, however, experts are unwilling to project a timetable for the changeover, because the timing of the transition depends upon U.S. industry's conversion schedule. This paper will discuss the impact on the Department of Defense before, during, and after conversion.

Conversion is having relatively little impact on DoD right now. The Defense Department is just beginning to consider metric products in most of its procurement actions, and DoD management personnel are currently formulating policy, programs, and tasks to resolve anticipated problems. The specifications and standards community within DoD is also working with industry associations to develop metric specifications and standards needed for procurement of metric hardware. Even though the impact from activities now under way is minimal, these pre-conversion planning and policymaking efforts are important because they will influence the amount of disruption and cost to

tary of Defense for Acquisition. An significant DoD metrication policy originates from the Metrication Steering Group.

Revision of the DoD directive on implementation and management of the metric system, for example, was the work of the steering group. Issued in January 1980, the revised directive establishes as policy that DoD will consider use of the metric system in all its activities consistent with operational, economical, technical, and safety requirements. It requires use of the metric system in all new designs unless otherwise justified—due to lack of metric suppliers, for example. Only when some overriding reason makes conversion desirable, however, must existing designs with dimensions in inch-pound units be converted. This directive also recognizes that use of hybrid metric systems during the transition from inch-pound standards is necessary, and it acknowledges that DoD, as noted earlier, will follow industry in conversion.

DoD will be able to handle many of the technical and administrative issues created by metrication as it does other irregularities, through management systems already in place.

The Under Secretary of Defense for Research and Engineering has set January 1, 1990, as the target date for making available a complete spectrum of metric specifications and standards.¹ The goal is not that all DoD activities be metric by that date, but that standards barriers to metrication be removed. The 1990 target date should signal that DoD is not discouraging industry conversion. In

metric documents to parallel existing inch-pound specifications and standards. This guidance also covers the methods to be used when revising inch-pound standardization documents and establishes criteria for determining when new metric standardization documents are required.²

To meet the 1990 goal, the Army, Navy, Air Force, and Defense Logistics Agency standardization offices have begun to examine the specifications and standards under their cognizance. They are working with private industry, through the American National Metric Council, to set priorities for developing metric specifications and standards according to DoD needs and industry conversion schedules. At this point, approximately 80 percent of the metrication effort in the Defense Department is devoted to drawing up such specifications and standards. DoD personnel also serve on industry sector committees and are thus actively involved in formulating industry metric conversion plans and programs. To date, the American National Metric Council sector committees have developed and approved sector conversion plans for chemical and allied products and for instruments.

Although DoD's metric activities now center on long-term planning and policy development, the conversion process for some systems is already complete or well under way. Weapon systems partially or wholly metric include the Multiple Launch Rocket System, the Hellfire Missile System, the Patrol Hydrofoil Missiles ship, and the Division Air Defense System. In addition, some military operations (ground exercises, for example) are carried out using metric units.

The acquisition process is accommodating conversion to the metric system as well. Program managers responsible for designing, developing, and producing new weapon systems must inform the Defense Systems Acquisition Review Council if they decide not to use metric units and why. In

¹ Under Secretary of Defense for Research and Engineering Memorandum, March 7, 1980, subject: Metric Specifications

² Under Secretary of Defense for Research and Engineering Memorandum, December 1, 1980, subject: Use of the Metric

Measure for measure.

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² Under Secretary of Defense for Research and Engineering Memorandum, December 1, 1980, subject: Use of the Metric

coordinating a proposed list of metric issues to be addressed by program managers at milestone 1 of the Defense Systems Acquisition Review Council process.

This planning is valuable and necessary to the conversion process, but until a significant number of defense contractors are able to produce metric parts, most major weapon systems will not be wholly metric; they will be hybrids. Initially, manufacturers and contractors will probably offer an existing product line with external interfaces of the top assembly item "soft-converted," which involves a change from inch-pound to metric units without altering physical configuration. Most internal parts and assemblies will be retained and still expressed in inch-pound units. Hybrid systems will be necessary until all components and subsystems are available in metric units and, in the case of long-lived items such as ships and aircraft, may be in use for a significant period of time. In fact, estimates indicate that the Navy will be buying hybrid ships for another twenty years. Gradually, "hard-converted" parts and assemblies will enter the end-items (hard conversion entails a change from inch-pound to non-equivalent metric units and alters the physical configuration of the end-product); and eventually, the product itself will be designed in metric units or hard-converted to a metric product line.³

Unfortunately, as the chairman of the Metrication Steering Group has pointed out, using metric and inch-pound systems concurrently is costly, confusing, and a hindrance to federal agencies trying to fulfill their responsibilities to the public.⁴ However, the cost to U.S. industry will be less for voluntary conversion than for mandated conversion. Each company can schedule its own conversion based on its marketplace, its equipment replacement program, and its expansion program.

Especially in terms of standardization, the inch-

series; under metric standards, DoD has reduced this figure to 83. Given the ease of working with metric units, experts generally agree that conversion will simplify design and speed it up as well, perhaps by as much as 25 percent. Savings will result from the opportunity to rethink, reengineer, simplify, and even retool.

The Defense Department is just beginning to consider metric products in most of its procurement actions, and DoD management personnel are currently formulating policy, programs, and tasks to resolve anticipated problems.

In general, as indicated earlier, the Defense Department will use metric items as they become available from private industry. Because conversion is voluntary and incentives to convert vary among industries, projecting a timetable for the changeover to metric, whether within industry or DoD, is impossible. To complicate matters, some industries, for example, the railroad industry, have little incentive to convert and may never do so. These factors make coordinating the conversion within DoD a difficult task at best. Some experts believe that complete conversion will require from 30 to 50 years.

The major exceptions to voluntary conversion are those systems which must meet NATO rationalization, standardization, and interoperability requirements immediately. As set forth in Directive 4120.18, DoD is to adopt the metric system when:

- There is a specific military need for materiel to be used jointly with NATO and other allied nations.

- Military materiel has a potential for significant

³ Department of Defense Memorandum 246080, July 20, 1977, subject: Military Specification Metric Machinery/Equipment, General Requirements for.

⁴ Howard B. Ellsworth, "Federal Metrication Policy and

accrue, or no disadvantage is incurred.¹

When DoD is committed to interoperability, it will lead industry into conversion and as in the past, will pay the costs attendant upon achieving interoperability.

Personnel responsible for converting DoD systems and operations to the metric system realize that they need to resolve several problems. Among them are acquisition barriers; potential adverse impact on small and disadvantaged businesses; conflicts with policies that encourage remanufacturing, thereby extending the life of inch-pound designs; part identification problems; dual inventories; and training of DoD personnel. Moreover, standardization personnel are questioning where the resources to develop new metric specifications will come from. Some report that they already lack sufficient resources to maintain and develop the inch-pound specifications and standards still needed. Conversely, others contend that the level of effort required to develop metric specifications is overstated, especially in areas in which private industry is now developing those specifications and standards. The DoD Metrication Steering Group is considering these issues.

The uncertain future of the U.S. Metric Board may also pose problems for conversion to the metric system. The purpose of this independent federal agency, created by the Metric Conversion Act, is to coordinate metric conversion in the public sectors. Now scheduled for elimination on September 30, 1982, its impending demise has created the perception that metrication in the U.S. is losing momentum, although Dr. Richard DeLauer, the Under Secretary of Defense for Research and Engineering, has pledged continued support for DoD's transition efforts.

All these problems are important and need to be dealt with. But they should also be kept in perspective. DoD will be able to handle many of the technical and administrative issues created by metrication

probably be handled as would any other new hardware or materiel.

Some might argue that DoD's emphasis on policy development over hardware conversion parallels private sector caution toward changing to metric measurements. But while defense metrication plans are directly linked to the pace of conversion in American industry, the comparison ends there. Defense planners have gone beyond acknowledging the cost-saving and efficiency potential of conversion and have been fielding both hybrid and total metric systems and procedures. Moreover, defense planners have been working closely with private industry to plan an orderly transition.

From DoD's perspective, the most important aspect of metricizing will be achieving interoperability of our systems and procedures with those of our allies. Also, it is within the realm of NATO rationalization, standardization, and interoperability that the Defense Department has gained valuable experience in converting systems and operations to metrics. The lessons learned in these areas should assure a smoother changeover. Indeed, some believe that these lessons make DoD one of the most experienced federal departments in converting to the metric system of measurement and a possible standardbearer for any future conversion. **DMJ**

GARY R. DILLARD is the executive secretariat to the Department of Defense Metrication Steering Group, in which capacity he provides technical and administrative support for coordinating metric activities in the defense agencies. Previous positions with NASA, the Department of the Navy, the DoD Product Engineering Services Office, and the Defense Logistics Agency have given him a broad background in aeronautical engineering, quality and reliability assurance, value engineering, and production management. Mr. Dillard received his bachelor's degree in aerospace engineering from the Mississippi State University.

¹ Department of Defense Directive 4120.18, January 28, 1982.

Scientist shortage in DoD

According to a recent DoD white paper, the nation faces a shortage of skilled engineers, scientists, and technicians in fields "particularly critical for Defense." The paper questions the ability of DoD and the services to compete with the private sector in attracting either military or civilian engineers and scientists, since starting salaries are \$4,000 to \$6,000 higher in private industry.

In addition to recruiting difficulties, according to the paper, the department has "serious problems" keeping highly qualified and experienced personnel now on the payroll. Inferior facilities and equipment in laboratories and the lack of opportunity for growth and advancement contribute to retention problems. Those who do remain, the white paper points out, "are by and large an aging laboratory population."

A related problem is the inability of American colleges and universities to provide the quality and quantity of technical graduates needed to fill the increasing demands of government, industry, and even the universities themselves. The demand for technical skills is outstripping the supply, and the government is at a dis-

advantage in competing for technicians against the private sector, whose salaries are much higher.

Moreover, foreign students account for a large number of those seeking degrees in science and engineering; in 1979, foreign students comprised 40 percent of all enrollees working toward master's degrees in engineering and science and 47 percent of students seeking doctorates in those areas. The Defense Department does not hire foreign specialists to work on defense programs; thus, larger foreign enrollments decrease the pool of potential American recruits for DoD or defense industry jobs.

A two-part study recently released by the Congressional Research Service discovered that U.S. technical education lags behind that of both the Soviet Union and Japan. The study found that the Soviets graduate twice as many scientists and engineers as the United States and have almost five times as many engineering students. It also included an Air Force projection showing that the nation's shortfall of engineers will reach 114,000 over the next decade.

Both the services and private organizations have done numerous studies of the overall shortage. However, only piecemeal ef-

forts are under way to counter the problem. The Air Force, with the largest requirement of any service for technical expertise, fought hard to get Congress to approve a law authorizing bonuses of up to \$3,000 for science and engineering officers who agree to serve on active duty. However, Congress has yet to appropriate the funds to pay the bonuses. Even when those funds are approved, only the Air Force plans to pay the bonuses.

The Department of Defense has also set up a Science and Engineering Apprenticeship Program, but it will not begin providing technical specialists until at least 1985. Under Secretary of Defense, Research and Engineering, Richard DeLauer has ordered a comprehensive study of the reasons behind the shortage of national and defense scientists and engineers. That effort is expected to result in a plan of action to help resolve DoD's in-house problems and to reverse a potential national technological fallop.

Oversight office established

Secretary of Defense Caspar Weinberger has established an Office of Management Policy to monitor the implementation of major management

initiatives undertaken this past year in the Department of Defense. Vincent Puritano, the Executive Assistant to Deputy Secretary of Defense Frank C. Carlucci, will serve as director of the new office and will report directly to the deputy secretary.

The Office of Management Policy will be responsible for tracking developments in the following areas: the planning, programming, and budgeting process; the strengthening of the Defense Resources Board to enable it to participate more effectively in the budget process; the 32-point program for streamlining the weapons acquisition process; the establishment of the review and oversight office to focus the department's audit, inspection, and investigation efforts against fraud, waste, and inefficiency; and monitoring the economics and efficiencies resulting from the actions of the Department of Defense Council on Integrity and Management Improvement.

Mr. Puritano will continue serving as the Executive Assistant to the Deputy Secretary of Defense and as the executive secretary to both the Defense Resources Board and the Department of Defense Council on Integrity and Management Improvement.

Event	Date	Place	Contact
Fundamentals of Data Processing for the Non-Data Processing Executive	Jun 7-9 " " Jun 16-18 Jun 21-23	New York, NY Chicago, IL Dallas, TX Boston, MA New York, NY	American Management Associations 135 West 50th Street New York, NY 10020 (212) 586-8100
Improving Your Managerial Effectiveness	Jun 7-11 " Jun 14-18 Jul 5-9 Jul 26-30	Arlington, VA New York, NY Newport Beach, CA Chicago, IL San Francisco, CA	
Management Skills for the Professional Woman	Jun 8-9	Boston, MA	Human Productivity Institute, Inc. P.O. Box 3181 Boulder, CO 80303 (303) 447-0742
Audit and Control of On-Line Systems	Jun 9-11	Washington, DC	The Institute for Professional Education 1515 N. Court House Road Arlington, VA 22201 (703) 527-8700
Successful Program and Project Management	Jun 16-18	Washington, DC	
Adverse Actions	Jun 9-11	Washington, DC	Graduate School, USDA Career Planning and Development Programs Capital Gallery 600 Maryland Avenue, SW Washington, DC 20024 (202) 447-7124
Introduction to Federal Personnel Procedures	Jul 7-9	Washington, DC	
Changing Management Approaches for the Future: Participation and Quality of Work Life	Jun 17-18	Washington, DC	Graduate School, USDA Special Programs 600 Maryland Avenue, SW Washington, DC 20024 (202) 447-3247
Increasing Productivity Through Stress Management	Jul 8-9	Washington, DC	
Management Development Program for Executives in Scientific and Engineering Organizations			
Phase 1	Jul 22-23	Washington, DC	
Phase 2	Sep 19-24	Virginia Beach, VA	
Phase 3	Oct 14-15	Washington, DC	
Information Resources Management	Jun 28-30 Jul 26-28	New York, NY San Francisco, CA	NIMR Seminars P.O. Box 3727 Santa Monica, CA 90403 (212) 450-0500